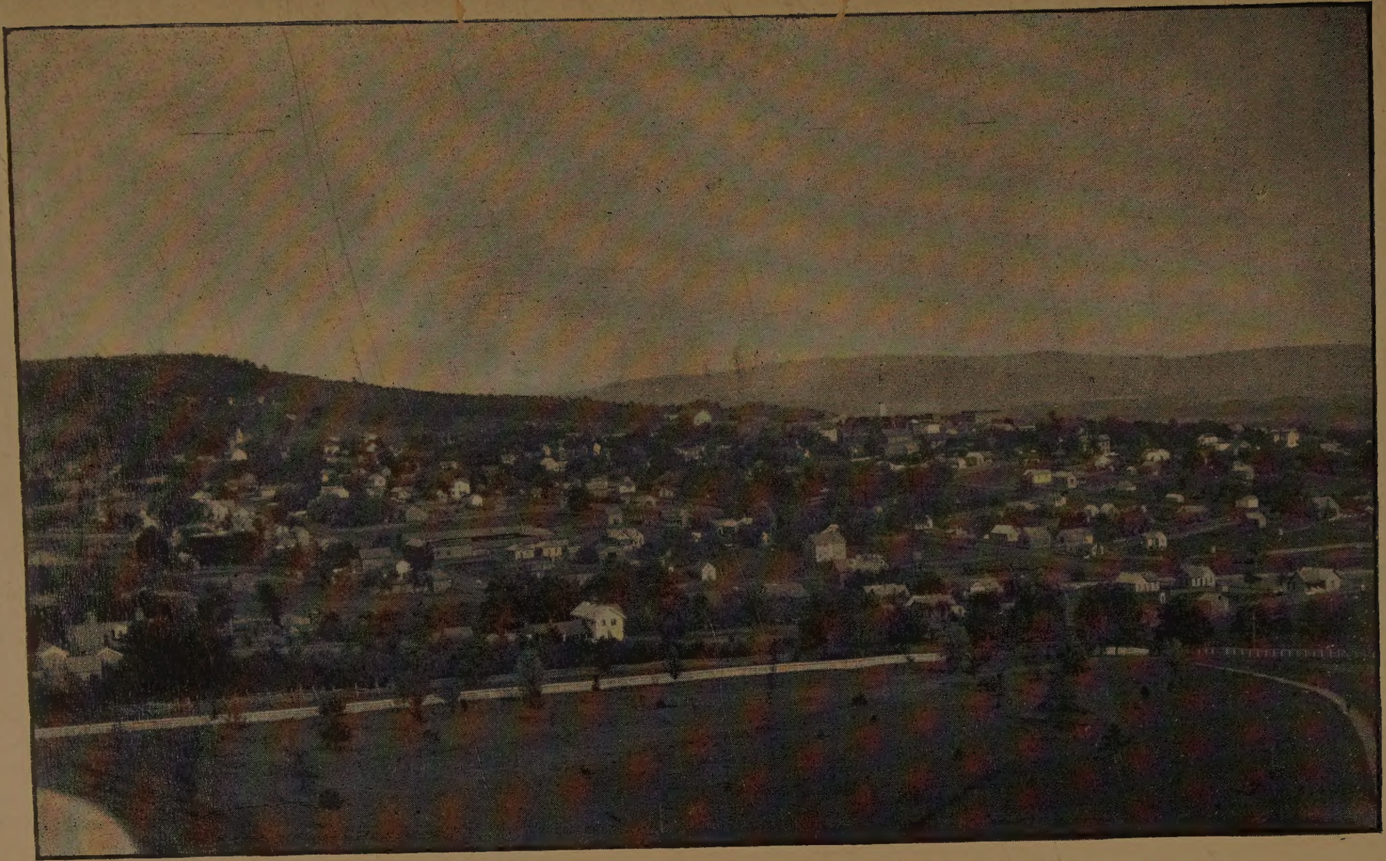

FAYETTEVILLE, LOOKING EAST FROM THE ARKANSAS INDUSTRIAL UNIVERSITY.

ANNUAL REPORT

OF THE

GEOLOGICAL SURVEY

OF

ARKANSAS,

FOR 1888.

IN FOUR VOLUMES:

VOL. I. ADMINISTRATIVE REPORT.
REPORT UPON THE GEOLOGY OF WESTERN CENTRAL ARKANSAS, WITH ESPECIAL REFERENCE TO GOLD AND SILVER.
VOL. II THE NEOZOIC GEOLOGY OF SOUTHWESTERN ARKANSAS.
VOL. III. THE GEOLOGY OF THE COAL REGIONS.
VOL. IV. WASHINGTON COUNTY. PLANT LIST.

JOHN C. BRANNER, Ph. D.,
State Geologist.

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1891.

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Vol. 4

ERRATA.

Page 7. Third line from the top, for "northern," read *western.*

Page 19. Twelfth line from the top, for "16 N., 39 W.," read *16 N., 31 W.*

Page 63. Seventh line from the bottom, for "31 feet," read *31 inches.*

Page 84. In the list of occurrences, for "At Mr. Sloan's, in 14 N., 31 W., section 7," read *At Mr. Sloan's, in 14 N., 31 W., section 17.* In the same list, for "Evansville, in 13 N., 32 W.," read *Evansville, in 13 N., 33 W.*

Page 86. Fourth line from the top, omit "species of."

Page 88. Ninth line from the top, for "size," read "size, the discs."

Page 98. Fifth line from the top, for "section 22," read *section 24.*

Page 101. In No. 5 in the list, for "southeast of northeast," read *southwest of northeast.*

Page 106. Second line from the bottom, after "Fall Creek," insert semi-colon.

ANNUAL REPORT, GEOLOGICAL SURVEY OF ARKANSAS.

1888.

VOL. IV.

PART I. THE GEOLOGY OF WASHINGTON COUNTY.

By F. W. SIMONDS, PH. D., Assistant Geologist.

PART II. A LIST OF THE PLANTS OF ARKANSAS.

By J. C. BRANNER AND F. V. COVILLE.

TABLE OF CONTENTS

INTRODUCTION.

It is the plan of this Survey to study and to report upon geologic topics rather than upon geographic areas. An exception has been made of Washington county, however, for two reasons:

First, the geology of the county embraces a complete section at the westernmost exposure in the state across the lower carboniferous rocks from the base of the Coal Measures to the Silurian.

Second, the location of the State University at Fayetteville makes it desirable that the geology of the surrounding region be worked up in detail for purposes of instruction.

Care has been taken to render the county map accompanying this report trustworthy so far as it goes, both in respect to the geology displayed upon it and for general purposes.

The base of the map was prepared by Professor Simonds, the author of the report, but the geology has been worked out, and contributions made by various persons as follows:

By Professor F. W. Simonds in townships 15, 16 and 17 north, range 30 west, in townships 16 and 17 north, range 31 west, in township 15 north, ranges 28 and 29 west.

By Gilbert D. Harris in townships 16 and 17 north, range 29 west.

By T. C. Hopkins in townships 16, 17 and 18 north, range 28 west, in 18 north, 29, 30 and 31 west.

By Claude E. Siebenthal in township 15 north, range 31 west, and townships 16 and 17 north, 32 west.

By Horace E. Williams in townships 13, 14, 15 and 16 north, range 33 west, and townships 14 and 15 north, range 32 west.

By Wm. N. Crozier in the east half of township 15 north, range 30 west.

The system of geologic coloration used on the map is that recommended and employed by the United States Geological Survey. The scale of the map is so small, however, that it is not possible, either with this or with any other system that might be devised, to represent all the details of the several outcrops.

To the bibliography the following title should be added:

A Pictorial History of Arkansas by Fay Hempstead, New York, 1890; Washington county, pp. 938–945.

All vertical measurements given in this report, unless otherwise stated, were made with the aneroid barometer.

The plant list is given in this volume partly because it will probably be used more at the State University than elsewhere. Remarks introductory to the plant list will be found on pp. 155 to 161 immediately preceding the list.

With certain exceptions the provisional names applied to the formations mentioned in this report have been left to the discretion of Professor Simonds; but where it has been possible to correlate the Washington county formations with those in other parts of the state, the provisional names used by the Survey have been applied to the formations of Washington county also. The sub-divisions made in the Washington county rocks, however, are based upon stratigraphy and structure rather than upon biologic evidence, so that no great confidence is felt in the ultimate maintenance of the classification adopted; when the paleontology of the region shall have been worked up it may be changed.

The following table will explain, so far as they can be explained at present, the relations of the provisional names used in this report to those used elsewhere. The authorities for the names used are given in parentheses:

THE FORMATIONS OF WASHINGTON COUNTY.

System.	Series.	Group.	Approximate Equivalence. (H. S. Williams)	Washington County.
Carboniferous or Pennine.	Coal Measures or Pennsylvanian (H. S. Williams)			Millstone grit.
		Boston (Branner). Genevieve (H. S. Wms).	"Chester." "St. Louis." "Warsaw."	Kessler limestone (Simonds.) Coal-bearing shale (Simonds.) Pentremital limestone (Simonds) Washington shale and sandstone (Simonds). Archimedes limestone (Simonds). Marshall shale (Branner).
	Lower Carboniferous or Mississippian (H. S. Wms.)	Osage (H. S. Wms).	"Keokuk." "Burlington."	Batesville sandstone (Branner). Fayetteville shale (Simonds). Wyman sandstone (Simonds). Boone chert and limestone (Branner).
Devonian ?				Eureka shale (Branner).
Silurian.				(Sandstones).

The observations of Messrs. Hopkins, Siebenthal and Williams, made since the body of this report was printed, have added much to our knowledge of the Eureka shale. Its distribution in the county is shown on the map, although several of its exposures are not mentioned in the text. In township 16 north, range 32 west, section 11, the Eureka shale is not less than 50 feet thick, and beneath it about 15 feet of Lower Silurian sandstones are exposed.

Along the White River in the extreme northeastern corner of the county the Eureka shale is about 50 feet thick. In township 18 north, range 29 west, sections 13 and 18, this shale has about 60 feet of Lower Silurian sandstone exposed beneath it No Silurian beds are now known in Washington county on the White River, but it is probable that there are small exposures of those rocks in that portion of the county. The Lower Silurian area in Washington county is so small that no attempt is made to show it on the map.

It was hoped that the report on Washington county might treat many topics that have necessarily been omitted. This is especially to be regretted in regard to the paleontology. But even as it is Professor Simonds has devoted much more time to the work than the Survey has been able to pay him for. Indeed, since he went to Texas he has personally met the expense of a trip to Washington county for the purpose of making additions to the work.

The economic results here brought out are of no great positive value; indeed such results were not anticipated. The coal of the county is too thin to be of more than small local importance. Gas and oil, concerning which there is occasionally more or less excitement, are not to be expected in paying quantities; the occurrence of both in small quantities is not evidence of value one way or the other. The study of the geology of the region east of Washington county reveals the character of the rocks far below the lowest rocks exposed in Washington county, and none of these rocks warrant the expectation that oil or gas will be found in them. The probability of lead occurring in the Boone chert formation will be considered in the report upon lead and zinc now in preparation.

The citizens of Washington county have contributed in every way in their power to the success of the Survey's work, and the Survey regrets that it cannot report the county rich in minerals. In spite of this defect, if it is one, Washington county has those elements of healthfulness, mildness of climate, fertility of soil, educational advantages, railway facilities, and cordial hospitality of people that must always render it one of the most attractive places of residence in the State of Arkansas.

JOHN C. BRANNER,
State Geologist.

THE GEOLOGY OF WASHINGTON COUNTY.

By FREDERIC W. SIMONDS, Special Assistant

CHAPTER I.

TOPOGRAPHIC FEATURES.

The rocks of Washington county are limestones, sandstones, shales and cherts, which lie in horizontal beds. In these beds erosion has cut out gullies, gorges and valleys, narrow and broad, and has left behind many flat-topped hills and mountains.

These rocks, moreover, vary much in hardness and in their ability to withstand weathering influences. When subjected to erosion, this difference gives rise to a varied topographic expression. Wherever the harder rock prevails there is usually a bench around the mountain, terminated exteriorly by a bluff, giving rise to what is known as bench and bluff topography. The bluffs are of limestone or sandstone, and their wasting away is very great; they are undermined, as they usually rest upon a softer rock, shale or flaggy sandstone; their overhanging masses are fissured, and broken up by frost; and vegetation—the roots of trees especially—penetrating small cracks, assists materially in wedging off large blocks. The accumulated debris of the limestone bluffs skirting the mountains, as mentioned in the body of this report, is remarkable, blocks of immense size having been tumbled together in the greatest confusion. The chemical action of water upon limestones is well understood, and their destruction by solution is by no means small.

But the wasting of rocks does not cease here; the fragments themselves are in the process of slow decay, and ulti-

mately the material which constitutes them will be borne away by running water or the fragments themselves will be carried down some mountain torrent and worn to minute size, if not ground to powder. This material deposited in the valleys forms the alluvium of the bottoms, or transported to the sea it is again deposited over the ocean's bed as sediment.

While the limestones and sandstones form benches and bluffs around mountains, shales, owing to the readiness with which they decay, form slopes. The following diagram shows a typical bench and bluff topography such as characterizes most of the mountains of Washington county.

Bench and bluff topography.

*Topography in the vicinity of Fayetteville.**—East Mountain rises nearly 300 feet above the bench upon which Fayetteville stands, and from this elevation a fair view of the surrounding country is obtained. The topography of this vicinity will therefore be described from different points of observation upon its summit. The observer standing upon the southeast corner of the flattened top and looking southward beholds in the distance the crest line of the Boston Mountains blending with the sky. In the foreground is the valley of Town Branch, with its cultivated fields and pasture lands, extending to the right; to the left the sinuous course of the West Fork of White River is marked by a fringe of trees. Across the valley of Town Branch, directly south of Fayetteville, is Baxter Mountain. So low does its flattened summit appear that the observer looks down upon its orchards and fields, which stand out prominently in contrast with its timbered slopes.†

*See the frontispiece, which shows the topography of Fayetteville.

†The geologic structure of this and other mountains will be understood by reference to chapter XIII. of this volume.

To the southwest rises McCullom's Mountain, sending northward a long narrow spur, while over the summit of Baxter Mountain the top of Miller Mountain is barely seen. Further to the westward Kessler Mountain, a long narrow ridge, cuts off further view in that direction.

East of Baxter Mountain stands Brooks' Mountain, similar in appearance, but slightly higher, and of much less surface area, and skirted on its southern and eastern sides by West Fork. Turning now to the southeast, there rises from the valley just beyond the river (West Fork) a low conical hill, locally known as Sulphur Springs Mountain, with Fisher Mountain and its spurs in the background. (S. W. corner of 16 N., 29 W.)

Farther to the east the valley broadens and here, West, Main and Middle Forks unite, forming White River. Facing now to the east, directly below is an indentation of the valley of Town Branch entering, gulf-like, between East Mountain and Tuck's spur of Pierce Mountain, while in the distance, beyond the White River valley, stands Round Mountain with its even slopes and high summit—a landmark for miles.

North of east, across a sandstone bench which slopes rather abruptly into the gulf-like expansion of the Town Branch valley, is Pierce Mountain with its level summit laid off into orchard and field. To the northeast between these mountains, glimpses may be had of the hilly region in township 17 N., 29 W., with its long cultivated slopes, while far beyond rise the ridges east of the White River.

Let the observer now change his position to a point on the summit near the southwest corner of the northwest quarter of the northeast quarter of section 15 (16 N., 30 W.) Looking west, immediately below is Fayettville on a broad bench, with a low rounded hill beyond, crowned by the University, followed by Archais Mountain and, at a greater distance, a little south of west, Millsap's Mountain. In the southwest there is a valley which passes through a gap between Millsap's Mountain on

the north, and Washington and Kessler Mountains on the south. Through this a glimpse may be had of the great limestone plain which extends to the mountains in the western part of the county.

In the northwest there is a valley followed by the low flint ridges which border Clear Creek. The ridge just north of this valley, and extending in a north-of-east and south-of-west direction results from an undulation of the cherty limestone which dips south under the Fayetteville shale, the latter filling the depression.

Rising above the crests of the Wedington Mountains which constitute the horizon, two well marked table-topped mountains appear as prominent topographic features and landmarks beyond the borders of the county.

To the north is seen a mountain extending from the center of section 10, 16 N., 30 W., into the southeast of section 35, 17 N., 30 W. Slightly east of north, across a mountain cove in the foreground, a vista opens between East Mountain on the right, and that just mentioned on the left, revealing a comparatively level tract with French's Mountain, which lies northeast of Springdale, in the distance. West of north, the southeast portion of the hill, lying just north of the corporation line of Fayetteville, is brought to view with its scrubby oak growth and barren shales, while beyond it appears a continuation of the valley lying south of the flint range previously mentioned.

The topography north of Fayetteville.—In township 17 N., 30 W., chert ridges and hills are prevalent along Clear Creek. Both north and south of it the country is much broken by gulches and ravines, and it is frequently so covered with flinty debris as to be almost if not entirely worthless for agricultural purposes. A flint covered ridge in the southeast of the southwest quarter of section 22, measures 110 feet* above the railway. This is mentioned to give an idea of the effect of flint ridges upon the topographic relief of the country. The north-

*Barometric measurement.

ern sections of this township, while in many instances flinty, are comparatively level.

In the south half of section 35 there is the northern extremity of the sandstone-capped mountain, heretofore mentioned as extending northward from near the center of section 10, in 16 N., 30 W., and from it there extends diagonally across section 36, in a northeast direction, an elevated sandstone area. The only other mountain in this township is on the range line, near Fox Mountain (on the southeast corner of section 24, the northeast corner of section 25, 17 N., 30 W., and the southwest corner of section 19 and the northwest quarter of section 30, 17 N., 29 W.)

The topography east and northeast of Fayetteville.—Little need be said concerning the topography of 16 N., 29 W., for the numerous limestones serve very well for contour lines. The distance between them is well shown in various sections given elsewhere in this report. There are, however, three valleys entering this township, the West Fork, the Middle Fork and the Main Fork valleys, separated by high land, and in section 32 all the strata from the Fayetteville shale to the Millstone grit occur. The prominent mountain, however, is Round Mountain, having its summit near the middle of the west half of section 14.

West of the great diagonal syncline in 17 north, 29 west (see the accompanying map of Washington county), the surface is generally very regular. It is a great plain upon which there still remain a few weatherworn mountains, viz.: Fox* (in section 19), Price and Webber Mountains. Their composition serves to show what once covered this great chert plain. To the observer standing on this plain the only other mountain at all imposing is that seen in the southern part of section 29. Walking southward along the section line between

*This mountain should not be confounded with a mountain of the same name in section 29, 18 N., 29 W., northeast of Springdale. See note at the end of this chapter.

sections 2–3 and 10–11, one would find the first mile of his journey exceedingly rough, while the second mile would be over a level area, and he would see to his right Price Mountain, Harp's Bluff, and the high land between them; whereas, to his left the country would appear level. This is true of the southern half of section 2 and the northwest diagonal half of section 11, but all the remaining area north of the White River and east of this line, excepting the river bottoms, is very much broken.

Proceeding southward the surface of the county is very irregular until the half mile line (east and west) running through sections 26 and 27 is reached. All south and east of this point to the river is comparatively level—another chert plain. Throughout such a journey, however, the vision is limited by a great, irregular but continuous rocky wall on the west. East of White River the land of this township, excepting the river bottoms and some sandstone areas, is very uneven and broken.

The topography south of Fayetteville.—Township 15 N., 30 W., is very rugged, the valley of West Fork extending diagonally across it. The stream enters the township at the southeast corner of section 32, and leaves it in the northeast quarter of section 3. On both sides the high lands are broken by hollows and coves. On the west there is a succession of bluffs in which the Archimedes limestone and the Batesville sandstone play prominent parts. The highest mountains in this township are, however, on the east side, the greatest elevation being near the center of section 36. High points also occur directly north of this, in the center of section 24, and near that of section 13. The latter has received the name of Parrick's Ridge, of which the former may be termed a spur. The summit of Round Mountain* is in the centre of the northeast quarter of section 27; that of White Oak Mountain in the northwest quarter of section 14. Between these mountains there is a very large ravine extending eastward from the West Fork valley and

*See note at the end of this chapter.

dividing in the west half of section 23, one arm extending into the southwest quarter of section 24, the other into the southwest quarter of section 13. In the northern part of the township the mountains are lower, but broken by numerous ravines and coves. The outline of these is well shown by following the course of the Archimedes limestone upon the geologic map accompanying this volume. Probably the highest point is Washburn Mountain, in the northwest quarter of section 19.

An extended view of the region here described may be had from the summit of Bloyd's Mountain, 14 N., 30 W., the northwest corner of section 3. Its height above the West Fork of White River, at the ford of the Fayetteville-West Fork road, in the southwest quarter of the southwest quarter of section 32, 15 N., 30 W., is 680 feet by barometric measurement. The elevation above tide of West Fork Station, in 14 N., 30 W., the northeast quarter of section 5, as given by Assistant Engineer Bond, of the St. Louis and San Francisco Railway, is 1354 feet; accordingly, the summit of Bloyd's Mountain must be about 2000 feet above the sea level. The outlook to the south is obstructed by timber. Looking north, the valley of West Fork, for its entire course through 15 N., 30 W., is spread out like a map. In the immediate foreground is the deep valley of Dye's Creek, beyond which is the dome-shaped summit of Round Mountain. Further to the east is Parrick's Ridge. Almost due north, and ten miles away over the top of Baxter Mountain, the sun illumines the houses of Fayetteville, the white cupola of the court house being especially conspicuous. Beyond Fayetteville, on the distant horizon, French's Mountain is seen. East of Fayetteville, East Mountain stands out in bold relief, to the right of which Webber Mountain is seen against the sky. To the left of Fayetteville, over Miller Mountain, the main building of the Arkansas Industrial University becomes visible. Across the West Fork valley, to the north-northwest, stands Kessler Mountain, with the gap south of it plainly marked, through which a vista of the great plain

about Farmington opens, with high land on the distant horizon. In the northwest is Rieff's Mountain, which lies across the gap south of Kessler Mountain. The horizon is now bordered by an interval of high land, which is again broken by a gap at a point about 10° north of west.

The topography northwest, west and southwest of Fayetteville.—Township 17 N., 31 W., is almost entirely of the Boone chert and cherty limestone, and its topography is largely that which characterizes those rocks. The streams flow through hollows and gulches having precipitous sides, while the water-sheds are chert-covered ridges. Especially is this true in the southern portion of the township, in the area bordering on Clear Creek. Through the southern halves of sections 25 and 26, for example, there extends a great hollow, into which numerous smaller ravines open, all having their sides completely covered with chert fragments. Along Wild Cat Creek, in the northwest quarter of this township, chert also occurs, while there is a comparatively level area in the northeast quarter of the township extending towards the southwest.

The only mountain in township 16 N., 31 W., is Kessler, which stands, for the most part, in the eastern half of sections 25 and 36. This is one of the highest mountains in the immediate vicinity of Fayetteville, and may be characterized as a narrow wall or backbone of rock, with foot-hills spreading out on its eastern side into sections 30 and 31 of 16 N., 30 W. Its summit at its widest point scarcely exceeds a quarter of a mile, and in many places it is but a few yards in width. From its summit one has an extended view. To the west lies a broad, apparently level tract, stretching to the Illinois River and beyond—the garden of Washington county. The underlying rock is mainly the cherty limestone, and, as would be expected, this plain is, in consequence, not entirely devoid of chert. The chert exposures are usually confined to the banks of the streams. The northern and northwestern portions of

this township are much broken, and in some localities chert covers the ground in great quantities.

The topography in the vicinity of Prairie Grove.—*The business portion of Prairie Grove lies in 15 N., 31 W., the southeast quarter of the southwest of section 18, though the corporation includes a square mile, with the northwest corner of the southeast of the southwest quarter of section 18 as its center. As the name of the town implies, the surrounding country was originally a prairie, but from this prairie there arise, at no great distance, several isolated hills, and beyond, skirting the southern, western, and southeastern horizons, are mountains. Two miles directly west of the village, South Mayberry Mountain rises from the prairie; north of west, North Mayberry Mountain, and south of west, Wolf Mountain, three similar peaks. Beyond these, to the west and southwest, are the Cane Hill Mountains, over which the Boonsboro road passes, in 15 N., 32 W., the northeast quarter of section 27. The Cove Creek road, leading south from Prairie Grove, passes through a gap of that name in the Boston Mountains, the highest point of which is in the northeast quarter of section 24, 14 N., 32 W., not far from the south line of section 13. South of east is Coal Bank Mountain, and southeast, Sharp's Mountain, both isolated elevations, separated from the main body of high land. The Pinnacle is a sharp-pointed hill, lying to the south. Its base covers about ten acres. It has a limestone foundation, but is largely composed of shale. East and northeast of Prairie Grove is the valley of the Illinois River. From the center of the town the land rises to the north, the institute building being at least thirty feet above the stone at the corner of Buchanan and Mock streets. This building stands about 100 feet above the water of the Illinois River at the ford on the Farmington-Prairie Grove road. West of Prairie Grove the land gradually

*The Survey is under many obligations to Mr. W. J. McCormick for valuable information concerning the country about Prairie Grove.

slopes to the bed of Marr's Creek or Muddy Fork, which, at the ford on the Boonsboro road, is but thirty feet below the corner of Buchanan and Mock streets in Prairie Grove. A fine view of the vicinity of Prairie Grove may be had from the summit of Wolf Mountain, near the center of section 23, 15 N., 32 W. At the height of 310 feet above Prairie Grove there is a perpendicular face of a sandstone bluff, twelve feet high, from the top of which one may behold the adjacent prairie, with its farms and town—a picture recalling that of the great limestone plain about Farmington, as seen from the summit of Kessler Mountain.

The topography of the Cane Hill region.—From the hill, back of the house of Robert Parks, in 15 N., 32 W., the southwest quarter of section 27, on the Cane Hill Mountain, at the height of 390 feet above Prairie Grove, a view may be had in every direction excepting the south, where it is obstructed by timber. To the north and northeast there is a great open plain. The elevated land in the far distance makes an almost continuous line, with the exception of an apparently twin-peaked mountain. To the east and the west the horizon is broken by mountains.

Boonsboro is situated in the east half of section 8, 14 N., 32 W. It lies in the picturesque valley of the Jordan, a tributary of the Barren Fork of the Illinois. On both sides of this valley there are conspicuous bluffs of limestone from a quarter to less than half a mile apart, surmounted by rounded hills. A quarter of a mile east of the Cane Hill mill there is a hill which may be taken as a type of those in the immediate vicinity. About its base runs a thick bed of limestone, while its summit is capped with sandstone. Looking north from this hill there is, directly in the foreground, a rather contracted valley, with rounded hills beyond, but a growth of trees prevents an extended view. To the northwest, across the Jordan, there is a hill, evidently of similar structure. Changing the point of observation to a hill slightly further to the south

(southeast of the mill), the rounded hills bordering the valley on each side of Boonsboro are plainly shown. To the southeast high land obstructs the view. East of south the Boston Mountains skirt the horizon. West of south likewise, glimpses may be had of the higher and more distant mountains of that range.

The Boston Mountains.—The principal range of the Boston Mountains enters Washington County from the west, south of Evansville, and follows an undulatory course through the southern townships of the county. From the southwest quarter of 13 N., 33 W., it tends to the northeast nearly to Hubbard Post-office, in 14 N., 31 W., where it falls back rather abruptly to the southern line of that township. Advancing again to the north, in the eastern half of 14 N., 31 W., it is a second time deflected southward, then southeastward to Winslow, in 13 N., 30 W. From this point it curves through the north half of 13 N., 29 W., and then passes from the county in a southeasterly direction. Thus there are formed a series of mountain recesses in which the head waters of several river systems have their origin: on the north, the different branches of the Illinois and White Rivers systems; on the south, Cove and Lee's Creeks, Frog Bayou and their tributaries.

These mountains form a notable barrier, and are nowhere passed without a marked ascent. On the railway the ascent between Brentwood and the tunnel at Winslow, a distance of five miles, is 251 feet. The descent on the south side is much more abrupt, amounting to 643 feet between Winslow and Porter, a distance of six miles.

The effect of this mountain barrier upon the climate is well shown by the character of the vegetation: on the south lies the cotton-growing country with its early spring and long warm summer, while the region north of the mountains is characterized by a vegetation similar to that of the States farther north, and, owing to its altitude, by a long delightful

spring and autumn and a comparatively short summer and winter.

A road from Evansville ascends the mountains in 13 N., 33 W., in a southeast direction, crossing section 27, until the flat-topped summit is reached, after which it bears south. At the highest point, near the line between sections 26 and 35, the altitude above Evansville at Littlejohn's mill, is 510 feet, that is to say, about 570 feet above the ford of East Fork, on the road from Evansville to Greersburg.

There is another road which, leaving Evansville from the east, passes up the East Fork bottom for a few miles and then ascends the mountain. Once on the summit it follows a general northeast course for many miles, finally uniting with the road from Boonsboro to Cove Creek in 14 N., 32 W., section 27. Near Antioch Church the barometer shows an elevation of 580 feet above the ford of the East Fork on the Evansville-Greersburg road, while in 13 N., 32 W., the southeast quarter of section 4, it marks 630 feet.

The road from Boonsboro to Cove Creek crosses the principal mountain range in 14 N., 32 W., section 27. The rise from the creek on the north side to the highest point reached by the road is 310 feet, but to the east of the road the mountain has a greater elevation.

The Cove Creek road passes through a gap a short distance south of Hubbard Post-office, the highest point of which is 330 feet above the Archimedes limestone at Morrow's Spring in 14 N., 32 W., section 36. The ascent on the south side of the mountains is up the bed of the creek, and for quite a distance is comparatively gradual. The descent on the north is abrupt.

At Winslow the mountain range is pierced by a tunnel 1760 feet long.

The following may be taken as approximate altitudes, based upon the railway levels to which barometrical measurements have been added :

Summit Home Hotel, in 13 N., 30 W., the southwest quarter of the southeast quarter of section 13, 1874 feet above tide.

Dr. Albert Dunlap's house, in the southeast quarter of the southwest quarter of the same section, 1954 feet.

Top of the hill south of this house, 2014 feet.

Mr. Woollum's place, east of the north entrance of the tunnel, 1904 feet.

Between the tunnel and Porter the railway crosses several deep mountain gorges; bridge No. 1 is 113 feet high, bridge No. 2, 119, and bridge No. 3, 98 feet.

The old Van Buren road, leading south from Winslow, follows the course of Howard's Branch. This is one of the steepest roads crossing the mountains.

Of the other roads leading from Winslow, that to Brentwood follows approximately the line of the railway; that to Woolsey's crosses the mountains in a northwest direction, descending into the bed of Winn's Creek, near Winn's Church, where it joins the well traveled road leading northward from Lee's Creek. Still another road passes from Winslow in a southwest direction, descending into the valley of Blackburn's fork of Lee's Creek.

While the main ridge ollows the course heretofore indicated, mention should be made of the elevated region between the West Fork and the Middle Fork of White River, in 14 N., and 15 N., 29 and 30 W.

A short distance south of White Church in section 10, in the former township and range, the road up the valley of Middle Fork divides; one branch continues up that stream and the other following a course west of south ascends the mountains, following, for the greater part of the distance, the bed of Greasy Creek. At Hobb's store, in the northeast quarter of section 28, the barometer indicated 360 feet above Middle Fork at the beginning of the ascent. Here the road again divides, one branch passing nearly west to Brentwood, the other

following a southeast course until it unites with the mountain road from Winslow to Sunset Post-office and Delaney.

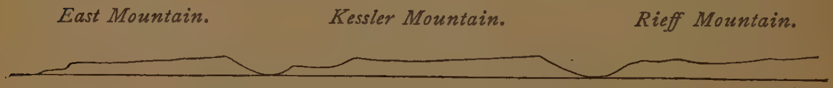
In 14 N., 30 W., sections 14 and 15, there is a high point known as Everett's, or Sugar Mountain. Its height is 750 feet above the railway station at West Fork, which would give it an altitude approximating 2100 feet above tide on the Gulf of Mexico.

Between the Middle and the Main Forks of White River there are elevated ridges and spurs, extending in a southwest direction from the southern part of 16 N., 29 W.

On the south side of the mountain Cove Creek has cut a deep valley. The rise between the creek, at Mr. Clanton's, 13 N., 32 W., near the center of section 23, and the southwest corner of the southeast quarter of the southeast quarter of the same section, is 360 feet, and between the same point and the "wire road," at Dale's, in the southwest quarter of the southwest quarter of section 25, it is 510 feet. The highest point, however, is near the center of this section, where the barometer indicated 630 feet above Mr. Clanton's.

The Wedington Mountains.—The road from Fayetteville to Cincinnati, by way of Ladd's Mill, crosses the Wedington Mountains at the gap, near the Benton county line on the northern border of 16 N., 32 W., probably in section 5. The height of the gap is estimated at 290 feet above the ford of the Illinois River, while the ridge itself rises considerably higher.

The road to Cincinnati by way of Rhea's Mill, crosses the



Looking north of east from near Rhea's Mill.

mountains in section 31 of the same township. The ascent from the mill is very steep, and the mountain side is covered with detached sandstone fragments. The highest point reached by the road on the northeast quarter of the southwest quarter of section 31 is 350 feet above Rhea's Mill. In this neighbor-

hood there are some high sandstone bluffs. Just south of the township line there is one which presents a perpendicular face 50 feet in height.

The topography in the vicinity of Cincinnati.—An extended view of the region about Cincinnati may be had from the top of Strayhan's Mountain, which lies along the west line of section 31, 16 N., 33 W. Its height is about 390 feet above the creek at Cincinnati, although at its southern extremity it may exceed 400 feet. Looking to the northeast, Lower Round Top Mountain and Upper Round Top Mountain and Wedington Gap, as a marked notch, are seen in the distance; to the east the county is high and mountainous; to the southeast is an isolated point, known as Bell Mountain; to the south, high mountains form the horizon; to the southwest are the prairies of the Indian Territory; while to the northwest are the brakes of the Illinois.

Bell Mountain lies at the point of junction of sections 4, 5, 8, 9, 15 N., 33 W., and rises about 400 feet above Cincinnati; *i. e.*, 240 feet above the surrounding country.

Six miles south of Cincinnati, the road to Evansville, after crossing Ballard's Creek, forks; one branch, continuing almost due south, passes over Sugar Mountain,* while the other passes around it by way of Salem Springs (Sexton Post-office). The road which crosses the mountains ascends by a steep grade, and then traverses a comparatively level tract through sections 28 and 33 of 15 N., 33 W. The main peak of the mountain, however, attains a much greater elevation. On the south side the descent begins in 14 N., 33 W., section 4.

A list of the elevations along the line of the St. Louis and San Francisco Railway is given at the end of this report.

*The local names given to the mountains are adhered to in this report. Unfortunately, these names are frequently repeated, both in this county and in other parts of the State. There are two Round Mountains in Washington county, viz.: In 16 N., 29 W., and in 15 N., 30 W. There are two Fox Mountains—one in 17 N., 29 W.; the other, in 18 N., 29 W.; and two Sugar Mountains, namely, in 15 N., 33 W., and 14 N., 30 W. The latter, however, may be distinguished as Everett's Mountain.

CHAPTER II.

HYDROGRAPHY NORTH OF THE BOSTON MOUNTAINS.

That portion of Washington county lying north of the Boston Mountains is drained by two river systems, namely, that of the White River on the east and that of the Illinois River, a tributary of the Arkansas, on the west. The divide or water-shed between these drainage basins passes through the western tier of sections in 15 N., 30 W., and into 16 N., 30 W., where it bends to the northeast, passing through the campus of the Arkansas Industrial University at Fayetteville. Here the drainage from the south end of the main building passes into the former system, while that from the north end of the same building passes into the latter. Leaving 16 N., 30 W., near its northeast corner, the water-shed follows in a general north direction through the western portion of 17 N., 29 W., thence, veering slightly to the northwest into Benton county, its course, for many miles, is followed approximately by the St. Louis and San Francisco Railway.

The White River drainage.—White River proper is formed by the confluence of Main, Middle and West Forks in 16 N., 29 W., the union of the first two occurring in the southeast quarter of section 21, while West Fork empties into the enlarged stream near the northeast corner of section 17. Main Fork has its origin in many small branches flowing from the Boston Mountains in 13 N., 25, 26 and 27 W. Its general course is to the northwest. Middle Fork, rising in the same mountains, in 13 N., 28 W., flows in a course about parallel to that of the Main Fork. Its principal tributary is Greasy Creek, which flows into it in section 10, 14 N., 29 W.

The head waters of West Fork are likewise in the Boston Mountains, in the southern part of 14 N., 29 W. From this point it flows northwest through 14 N., 30 W., east of north

through 15 N., 30 W., and thence in a general northeast direction to the White River. The most important tributaries of West Fork are Town Branch, which flows eastward between the hills just south of Fayetteville; Mill Creek, which has its origin in the southeast corner of 15 N., 30 W., and flows in a southwest direction through the north half of 14 N., 30 W., and Winn's Creek, which, rising in the southern part of the same township, flows nearly north, joining the West Fork near Wolsey's (Pitkin Post-office).

The valleys occupied by these three streams have been cut down through many feet of nearly horizontal sedimentary rocks, leaving an elevated, rugged region between them. After its union with West Fork, the White River flows in a very sinuous course; at first northwest, then north nearly to the northern boundary of 16 N., 29 W., where it is abruptly deflected almost due east, in which direction it continues for nearly three miles; it then bears northeast and is again deflected abruptly to the northwest, in the northwest quarter of section 31, 17 N., 28 W., forming a great bow, locally known as Oxford's bend; in 17 N., 29 W., section 15, occurs still another sudden deflection, this time in a direction north of east, forming Johnson's bend; again in 17 N., 28 W., section 18, there is an abrupt change in the river's course to a direction west of north, Davis' bend, in which it continues until it passes into Benton county. Owing to its sinuosity, it again appears in Washington county, crossing diagonally the north half of section 18 of 18 N., 28 W.

The valley of the White River is rather narrow, with, as a rule, bordering bluffs of limestone, in some instances from 150 to 200 feet in height. Occasionally, however, it broadens, as north of Wyman and at Davis' and Johnson's bends, where alluvial areas are enclosed. Of the tributaries of White River, Richland, Brush, and War Eagle Creeks are worthy of mention. Richland Creek has its origin in 14 N., 27 W., and 15 N., 27 W., southwest of Huntsville, and flows in the general direction so characteristic of Main Fork and Middle Fork,

that is, to the northwest. It empties into the White River at Oxford bend, 17 N., 28 W., in the northwest quarter of section 31. The general course of Brush Creek is parallel to that of Richland Creek. It rises west of Huntsville, in 16 N., 27 W., and unites with the White River in 17 N., 28 W., in the northwest quarter of section 7. War Eagle Creek has its origin in the region southeast of Huntsville, in Madison county. Only a part of its course lies within the limits of Washington county; it crosses the extremity of the northeast corner of the county, passing in a northwest direction into Benton, but re-enters Washington in 18 N., 28 W., the northeast quarter of section 15. Hence it flows in a sinuous general southwest course until it reaches a point over two miles south of the county line, where it curves to the northwest and finally, after some meandering, empties into the White River in 18 N., 28 W., the northeast quarter of section 18.

The White River is subject to occasional overflows, in some instances the water rising many feet above its ordinary level. It is probably for this reason that its water-power is not generally utilized.

As in all rugged countries, there are numerous deep ravines, opening into the river and creek bottoms, which, in times of rain, serve as temporary water courses, being filled with rapid-flowing torrents—active agents of denudation which have played an important part in this region.

The Illinois River drainage.—All that part of Washington county lying north of the Boston Mountains and west of the Fayetteville water-shed is drained by the Illinois River and its tributaries. The head waters of this stream are fed by numerous small branches rising in the mountains in 14 N., 31 W. It flows northeast, entering 15 N., 31 W., in section 34, not far from Moffit Post-office (Billingsly). Crossing this section it soon bears to the north, and from the northeast quarter of section 22 pursues a general northwest direction for many miles, entering Benton county from section 23, 17 N., 32 W. The

river now makes a great bend and finally takes a general southwest course, in which it continues until its union with the Arkansas in the Indian Territory. As, however, it finally leaves Benton county, it touches the extreme western corner of Washington county, cutting off a small part of the northeast quarter of section 2, 16 N., 34 W.

Among the tributaries of the Illinois River the following flow from the east: Sweetwater Creek, Farmington Branch, Clear Creek and Osage Creek. Sweetwater Creek empties into the main stream in the north half of section 17, 14 N., 31 W. Farmington Branch flows westward through the central part of 16 N., 39 W., over the cherty limestone. Clear Creek has its origin in several branches rising in the hilly region in the southeast portion of 17 N., 29 W. It enters 17 N., 30 W., in section 25, and flows in a direction a little north of west into the northeast quarter of section 27, thence west of north to near the center of section 22, from which point it bears north of west to the center of the north half of section 21, whence it flows in a general southwest direction to the eastern boundary of the south half of section 33, 17 N., 31 W., and then nearly due west to the river in the southeast corner of 17 N., 32 W. For the greater part of its course it flows through a narrow valley in the cherty limestone, and its banks are frequently steep and covered with chert. As in the region drained by the White River, many deeply eroded gulches open into this valley, rendering the surface quite irregular for some distance back from the creek.

Hamestring Creek, a tributary of Clear Creek, rises in the northwest corner of 16 N., 30 W., and flows for several miles through the north tier of sections in 16 N., 31 W. In section 4 it bends to the northwest and empties into Clear Creek in 17 N., 31 W., the southeast quarter of section 33, near Pegram's mill. Limestone and chert are the prevailing rocks, the strata frequently outcropping in the bed and along the banks of the stream. There are, however, in both of these

narrow valleys occasional widenings, forming alluvial bottoms.

Osage Creek, flowing in a southwest direction, crosses the northwest corner of Washington county, entering in 18 N., 31 W., the northeast of section 29, and leaving it in the northwest of section 31.

The northwest quarter of 17 N., 31 W., is drained by Wild Cat Creek, which, flowing in a northwest direction, empties into Osage Creek. Its valley, with its accumulation of angular fragments, partakes largely of the characters of those heretofore described. Brush Creek,* another tributary of the Osage, drains, for the most part, that portion of 18 N., 31 W., which is included in Washington county.

Mill Creek, which has its origin in the confluence of Marr's or Muddy Creek and Moore's Creek in 16 N., 32 W., the north half of section 34, flows nearly north to the Illinois, with which it unites in the south half of section 11 of the same township.

Marr's Creek and its branches drain the region north, west and south of Prairie Grove. Among its tributaries are Blair's Creek, flowing north from 14 N., 32 W., and Sulphur Springs Creek, flowing from the southwest part of 15 N., 31 W., and the northwest part of 14 N., 31 W.

Moore's Creek drains the region east and south of Rhea's Mill in 15 N., 32 W.

West of the Wedington Mountains, 16 N., 33 W. is drained by Cincinnati Creek in the west and south, by a branch known as Odel's or Packard's Creek in the north. These streams belong to the Illinois drainage system.

The southwestern part of the county is drained by the Barren Fork of the Illinois River, and by the East Fork, which is known also as Evansville Creek. Barren Fork rises in the mountains south of Boonsboro, in 14 N., 32 W. It flows northwest through 14 N., 33 W. into Indian Territory. A

*As in the naming of mountains, there is a marked tendency to repeat the names of creeks, even in the limited area of a single county. There are two Brush Creeks and two Mill Creeks in Washington county. The local names have been retained in all cases.

tributary, known as Jordan Creek, has its source in the many beautiful springs flowing from the Archimedes limestone at Boonsboro, and in its vicinity. It unites with Barren Fork in 14 N., 33 W., section 23.

The East Fork branch of the Illinois is really a tributary of Barren Fork. The general course of this stream in 13 N., 33 W. is northwest, although its head waters flow north, south and southwest.

HYDROGRAPHY SOUTH OF THE BOSTON MOUNTAINS.

The drainage south of the Boston Mountains.—Within the limits of Washington county, south of the Boston Mountains, there are numerous streams flowing in a southern or southwestern direction, through deep valleys. These are the head waters of Lee's Creek and Frog Bayou, both of which empty into the Arkansas River. The following are the most important: Cove Creek, which rises north of Morrow's school house, in 14 N., 32 W. It enters 13 N., 32 W. in section 1, and after a southwest course, it passes into Crawford county from section 34. Garratt Hollow Creek enters Cove Creek in this township from the west. Fall Creek flows through 13 N., 31 W. from north to south, and drains the west half of that township, while Lee's Creek proper drains its eastern half, as it does also the eastern half of the township, 14 N., 31 W., in which it rises. Blackburn's Fork of Lee's Creek drains 13 N., 30 W., while Frog Bayou drains 13 N., 29 W.

Springs.—As in all limestone countries, springs are abundant throughout Washington county. The largest issue from the Boone chert and cherty limestone, while many of value are found gushing from the Archimedes and Pentremital limestones. The following, in the immediate vicinity of Fayetteville, were gauged by Professor J. M. Whitham, of the Engineering Department of the Industrial University, upon the dates given. Within the corporate limits of Fayetteville are three springs of more than ordinary magnitude. Cato's Spring (also known as Harrison's Spring, Big Spring and Spout Spring),

is situated in a ravine at the foot of East Mountain. Here the water issues from the Pentremital limestone. May 21, 1887, its measured flow was at the rate of 12,067 gallons in twenty-four hours.

Lewis' Spring is near the line of the St. Louis and San Francisco Railway, south of the depot, between Dixon and Spring streets. This spring issues from rocks that immediately overlie the Archimedes limestone. It does not flow from the edge of eroded strata, like the preceding, but is rather a welling up of water. May 23, 1887, its flow was at the rate of 26,221 gallons in twenty-four hours.

Williams' Spring is in an east-west ravine that extends through the northern part of Fayetteville, and, in its general character, resembles Lewis' Spring, but probably differs in its geologic position, inasmuch as the sandstones near at hand are very much disturbed, being completely turned on edge. May 28, 1887, it discharged 8607 gallons in twenty-four hours.

The largest spring examined, is situated in 17 N., 30 W., the southwest quarter of the southwest quarter of section 15, and is widely known as Johnson's Spring, or The Big Spring. It wells up from the cherty limestone, and covers an area of perhaps an eighth of an acre. August 2, 1888, its measured capacity was 2,345,967 gallons in twenty-four hours. The flow from this and two smaller springs is utilized for power at Johnson's mill. On this date the mill flume was also gauged, showing a flow of 2,562,491 gallons in twenty-four hours. This locality may, in the future, be very valuable from an economic standpoint, as a source of water supply for the City of Fayetteville.

In 16 N., 30 W., not far from the center of section 2, a fine flowing spring issues from what appears to be the opening of a cavern in the Pentremital limestone.

At Elm Springs, in 18 N., 31 W., near the center of section 25, clear, sparkling water gushes from the cherty limestone, forming many springs along the bank of a small branch, locally

called Brush Creek, a tributary of the Osage. Several houses of the village are supplied with water from them, and with the necessary improvements these springs could be made a resort of some importance. In 17 N., 28 W., near the northwest corner of the southwest quarter of the northeast quarter of section 7, in the bed of Brush Creek (not to be confounded with that above mentioned), a short distance above its union with the White River, there is a very large spring, called Blue Water Spring. It issues from the cherty limestone.

Mention should likewise be made of the large, flowing spring in 17 N., 32 W., near the center of section 36. It issues from the same limestone, at or very near its point of contact with the Eureka shale. The water, as it flows from the rock, seems to be accompanied by a current of air.

At the residence of Col. J. P. Neal, at Prairie Grove, there is another beautiful spring, flowing from the same formation. In the neighborhood of Boonsboro, too, there are numerous fine springs gushing from the Archimedes limestone, and the same is true on the south side of the Boston Mountains, in the vicinity of Morrow's school house, on Cove Creek.

Occasionally, as might be expected, the sandstone formations furnish water. Water issuing from the shales is, as a rule, rather inferior for drinking purposes, owing to the salts carried in solution.

Wells.—In some localities difficulty is experienced in obtaining an unfailing supply of water for domestic purposes. Such is the case in the western portion of Fayetteville, particularly at the University and in its vicinity. The geologic formation immediately underlying this region is mainly sandstone above, followed by shale beneath, with the Archimedes limestone underlying both, and all dipping to the east. The difficulty is not entirely overcome in wells drilled to a depth of over 100 feet. At the base of the hill, however, that is, nearer the Archimedes limestone, an abundance of water is easily and readily obtained at moderate depths.

On the other hand, wells are sometimes dug and water obtained in localities that excite more or less wonder, as for example, on the summit of Kessler Mountain in 16 N, 31 W., the southeast quarter of section 36. At this place is a well which passes through four feet of gritty sandstone and 13 feet of shale. The top of the mountain, at this point, is less than a quarter of a mile across and the strata are practically horizontal, yet the supply of water is unfailing. This supply of water is probably maintained by the porosity of the sandstones. On East Mountain, near the corporation lines east of Fayetteville, a well thirty feet deep has been dug, on a narrow shale bench, above the Kessler limestone, in which there is an abundance of water. Here, likewise, the strata are practically horizontal and the well is within a few rods of the limestone bluff at the edge of the bench.

The wells in the village of West Fork are shallow, rarely exceeding twenty feet in depth. In some instances the water is so impregnated with salts derived from the shales as to be unfit for drinking.

CHAPTER III.

THE ROCKS OF WASHINGTON COUNTY.

The loose soil, loam, clay and alluvium scattered over the surface of Washington county are simply the residuary products of the decomposition of the rocks, mingled here and there with decayed vegetation. The hard rocks of the county are nearly all of sedimentary origin, that is, they were deposited as sediments or silts, coarse and fine, in the waters of the ocean. The coarser sediments formed the sandstones and grits, while the finer sediments formed the shales. That these rocks originated in this manner is shown by the ripple marks upon some of them, by the manner of their stratification or water bedding and by the remains of animals preserved in the rocks. These fossil remains are nearly all the hard parts of such animals as live in salt water: sharks' teeth, corals, and shells of various kinds. The only exception to the marine sedimentary origin of the Washington county rocks is the coal and its accompanying shales. The coal is of vegetable origin, and the shales adjoining the coal contain many impressions of ferns and the remains of spiders. The coal and the fossils in the shales accompanying it suggest that these few unimportant beds were deposited in low marshy grounds.

The limestones are made up largely of the debris of corals and calcareous shells and animal skeletons of various kinds, that were deposited over the ocean's bottom.

Stratified rocks are classified geologically according to their ages, but petrographically they may be distinguished by the nature of their sediments. The subdivisions given below, and used in describing the geology of Washington county, are based partly upon the nature of the rocks and the facility with which they can be distinguished from their accompanying beds, and partly upon their fossil contents.

The following table gives the order and ages of the Washington county rocks. The various horizons are arranged in their natural order:

THE FORMATIONS OF WASHINGTON COUNTY.

BARREN COAL MEASURES.....	XII.	Millstone Grit formation, including the mountain shales, sandstones and grits.
LOWER CARBONIFEROUS	XI.	Kessler limestone.
	X.	Coal-bearing shale.
	IX.	Pentremital limestone.
	VIII.	Washington shale and sandstone.
	VII.	Archimedes limestone.
	VI.	Marshall shale.
	V.	Batesville sandstone.
	IV.	Fayetteville shale.
	III.	Wyman sandstone.
	II.	Boone chert and cherty limestone.
DEVONIAN (?)	I.	Eureka shale.

Inasmuch as the limestones of this portion of Arkansas are especially well marked and characteristic, the position of other strata, as a matter of convenience, has been determined by reference to them.

These rocks will be discussed in the order in which they are numbered in the list above, beginning with the lowest or oldest ones.

THE EUREKA SHALE.

Characters.—The rock here spoken of as the Eureka shale immediately underlies the Boone chert. It is a very black, argillaceous shale and has a marked tendency to break up in prismatic blocks. Lithologically it closely resembles the Fayetteville shale, which occurs at a higher horizon. As yet no fossils have been discovered in the Washington county exposures of this bed, and its identification depends upon its stratigraphic position.*

*The Eureka shale is the same as the "Black Shale" of Dr. Safford, in Tennessee. It is referred by him to the Devonian, but the fossils found both in the Tennessee beds, and in the Eureka shale of Arkansas, do not necessarily place this shale in the Devonian, but would as readily admit of its belonging to the Lower Carboniferous. At Eureka Springs the Eureka shales grade into the overlying limestones, which are, according to Prof. Henry S. Williams, undoubtedly Lower Carboniferous.
J. C. BRANNER.

Exposures in Washington county.—This formation is well exposed at Mrs. Cook's Spring in 17 N., 31 W., near the center of section 32, on the road from Fayetteville to Cincinnati, by way of Ladd's Mill. At this point there are seen beneath the limestone bluff, 12 to 15 feet of dark shale, with hard, gray and black layers.

In several places along the road farther west it appears, and from the line of its contact with the limestone, there issue weak springs. It is, however, easily overlooked, as large quantities of flint fragments, working down from above, completely cover the few feet that would otherwise be exposed.

At a lower level the shale is encountered in the excavation for a tail race at Ladd's Mill. Again, at the ford of the Illinois, beyond the mill, it occurs in the bed of the river. Here it had been overlooked a number of times, but when the water is clear and low it may be plainly seen, and its peculiar structure recognized. To avoid the possibility of error pieces of this black shale were broken from the river bed and examined.

Still further west, in 17 N., 32 W., near the center of section 36, below a magnificent spring which bursts from the limestone, there are exposed from 12 to 15 feet of black and gray shale.

In the valley of the Illinois River, in the extreme northwest corner of the county, near the Benton county and Indian Territory lines, in 16 N., 34 W., the northwest quarter of section 1, and also in section 2, the cherty limestone is underlain by from 10 to 12 feet of black shale, showing the usual jointed structure and tendency to break up into prismatic blocks.

THE BOONE CHERT AND CHERTY LIMESTONE.

Characters.—The Boone chert and cherty limestone is characterized by layers of limestone, usually hard, compact and gray, interbedded with chert, white or gray on a freshly broken surface, but becoming brownish when exposed to the weather. It may be traced over a large extent of country by the chert fragments in the soil. In many places these fragments completely cover the surface. While the stoniest of

such land cannot be used for the purposes of cultivation, it generally affords a good growth of timber.

Near the water courses numerous small valleys and gulches have been cut out, leaving between them hills and ridges with steep slopes covered with chert fragments. Away from the water courses the surface is flat or slightly undulating, forming what is locally known as a "flat woods" country, in which the presence of chert can be frequently determined only by a very careful examination of the soil, and usually the only guide is a systematic examination of the wells. In passing, it may also be remarked, that where this condition prevails, in all probability the limestone is overlain by a thin stratum of sandstone, of which there may be no surface indications or exposures, the evidence being mainly that derived from the study of a few and widely separated well sections.

Distribution.—The prevailing rocks along Main Fork and West Fork, in 16 N., 29 W., as well as along the White River proper, in the same township, and also in 17 N., 29 W., and 17 N., 28 W., are the limestones and cherts of the Boone chert formation. Along West Fork they appear in two or three localities in 16 N., 30 W., first in a bluff 30 feet high on the east bank, in the southwest quarter of section 25. Layers of chert are here interpolated with those of gray limestone. In this bluff are several highly fossiliferous layers, in which crinoid stems are especially abundant, being often left in relief on the surface of the rock. Impressions of large brachiopods are also quite common here.

At the second locality the limestone occurs in the bed of the river near the north line of section 26; and the third locality is at the ford of the Huntsville road in the northwest quarter of section 24. A quarter of a mile below the ford, appearing at intervals in the river bank, near the center of the section, it forms a bluff on the right bank, capped with sandstone.

From the White River valley in the northwestern portion of 17 N., 28 W., the cherty limestone formation has been traced westward, underlying almost the entire northern half of 17 N., 29 W., broken only by the shales and sandstones, which rise island-like above it, forming Webber, Price and Harp Mountains, the last of which is connected with the large sandstone area lying to the south and west.

Some of the upper layers exposed in the northeast quarter of the southeast quarter of section 16, and also in the northeast quarter of the southwest quarter of section 4 in the last named township, present a peculiar appearance from the insertion of numerous angular fragments of fossils, chips of limestone, chert, etc., in the limestone, as a matrix.

Along the east bank of White River, in 17 N., 28 W., as in sections 7 and 18, the cherty limestone presents massive bluffs rising precipitously from the water's edge to the height of 150 or 200 feet, broken by numerous ravines almost always destitute of running water. Again in section 31 high bluffs are found along Richland Creek near its confluence with the White River. In one place at least there is a perpendicular wall of rock rising directly from the water. While the bluffs are more pronounced and attain a greater height on the eastern or right bank of White River, the limestone is by no means wanting on the left, as may be seen, for example, below the road skirting the river in the northwest quarter of the above named section.

The road to Spring Valley and Hindsville, by way of Macedonia Church, passes from Goshen, in section 32, up the bed of Dutton's Creek. This stream flows through a narrow valley in the cherty limestone, bordered by cliffs, which appear most prominently on the right bank. Leaving this valley, the road passes in a northwest direction, at first over a sandy interval and then again on to a cherty soil, in the southwest quarter of section 22. At the ford of Brush Creek, near Macedonia Church, on the north side of the road, there is a

bluff of limestone about 25 feet high. North of Macedonia, the road to Spring Valley crosses and skirts flint ridges until that settlement is reached in the northeast quarter of the northwest quarter of section 2.

Along the road leading southwest from Spring Valley to Head's Ford on the White River, chert is abundant. As in other parts of the county where chert ridges prevail, the slopes are abrupt and the hollows have steep, and not infrequently precipitous declivities, while the tops of the ridges contain arable land and are well-nigh level. In the northeast quarter of section 8, the road ascends a long chert-covered hill into the Brush Creek valley. Here, as in many other places, the chert forms a natural macadam.

In 17 N., 29 W., the northeast quarter of section 12, the Fayetteville-Eureka Springs road descends into the bottom land, adjoining White River, over a series of limestone layers, while fragments of chert are scattered in every direction. Although the chert is of common occurrence on the surface of this region, it is only in the valleys and gulches, or in artificial excavations, that its source is shown.

Nearly the whole of township 17 N., 30 W. is underlain by this limestone, the exceptions being: a narrow valley in which the Fayetteville shale prevails, extending across the township in a direction a little south of west, including parts of sections 24, 25, 26, 27, 34, 28, 33, 29, 32, and ending in section 31; and a mountain with shale at its base, which projects northward from 16 N., 30 W. into section 35, with a spur extending into section 36.

The country embraced in the sections extending east and west through the middle of this township are very much broken by chert ridges and ravines, rendering much of the land worthless for agricultural purposes. In the northeast quarter of section 27, east of and near the railway, the Fayetteville-Springdale road passes around a low bluff of limestone with the characteristic cherty layers, dipping at a low angle in

a direction east of south. This is interesting as showing the shale in the valley to the southward to be really above the limestone, although found at a lower level.

Immediately west of the railway, in the northeast quarter of section 27, and the south half of section 22, and skirting the left bank of Clear Creek, there is a high bluff containing much chert, but capped with a thick gray limestone (25 feet), which furnishes material suitable for the manufacture of good lime.

The northern tier of sections of township 17 north, 30 west, and the southern tiers of the township north of it, afford good, level or slightly rolling land. From the wells chert and limestone are taken. It is possible that the thin layer of sandstone already mentioned as covering the limestone, and to be hereafter described, prevails in this region. That it does in certain localities, we have positive evidence, not only from fragments found in the soil, but from the rock itself taken from excavations.

North of Fayetteville, in 16 north, 30 west, the cherty limestone first appears in a ditch a few yards east of the Fayetteville-Springdale road near the township line. From this point it may be traced westward, through sections 4 and 5 for a mile and a quarter, where it bends to the southwest, underlying the west half of section 5, all of section 6, a large portion of section 7, and most of the northwest quarter of section 8. The interesting features of this region are: first, the occurrence of sandstone upon the limestone in the north half of section 7, and also in the northwest of section 8 and to some extent, probably, in the sections 5 and 6 lying north of these; second, the occurrence of a bed of gray shale eighteen inches thick interpolated in the limestone, as shown in a well near the township line in section 4, a section of which is as follows:

Soil	8 feet.
Limestone	8 feet.
Gray shale	18 inches.

In the section of a well in 17 north, 30 west, the southwest quarter of the southwest quarter of section 35, which shows three feet of limestone, followed below by eighteen inches of gray shale, with cherty limestone at the bottom.

All of township 17 N., 31 W. is covered by cherty limestone. The southern half of the township is, for the most part, very rough, and chert ridges and ravines follow one another in rapid succession. Through these hills Clear Creek flows in a general southwest course through sections 24, 25, 26, 27 and 34, then in a nearly west course through sections 33, 32 and 31. Barometric measurement shows some of the ridges, as for example, in section 35, to be from 120 to 140 feet above the bed of the creek. It must not be supposed that the ridges here mentioned have resulted from the elevation of strata: they are, like all the hills of the county, due to erosion, or wearing away by streams of the surface of the country more rapidly in some places than in others.

Arable lands are found at various points in Clear Creek bottom, and in places even on the tops of the ridges, considerable areas are found, comparatively free from chert, or where the cherty fragments are not large enough or abundant enough to impede the plow.

The comparatively level land, known as "flat woods," extends from the northeast corner of this township (17 N., 31 W.), in a southwest direction, to the vicinity of Wheeler Post-office (southeast quarter of the southeast quarter of section 20), broken in section 15 by Wild Cat Creek, which stream is bordered by cherty ridges.

In township 16 N., 31 W. chert and limestone occur along Hamestring Creek. The limestone exposed in a small quarry on the north bank of the creek in the northeast quarter of the southwest quarter of section 1, seems to be of excellent quality, of a gray color, hard and compact. Similar limestone outcrops in the banks of a branch of this creek, in

the southwest quarter of the northwest of the same section. At the latter point, it has been quarried and burnt for lime.

The old Fayetteville-Cincinnati road, in the southeast quarter of section 15, bears to the southwest, following for over a half a mile the bed of Shreve's Branch, in which both limestone and chert are exposed in place, while in every direction cherty fragments occur in the greatest abundance. From the northeast quarter of the northwest quarter of section 22, this road follows the Farmington Branch (with which Shreve's Branch is united), until it reaches the Illinois River. For the entire distance chert fragments prevail, with occasional exposures of hard gray limestone. This limestone is especially well shown near the point of crossing of the road and the half section line between the southeast and southwest quarters of section 16. North of the road it occurs in the bed of a small stream, while south of the road, and a little to the west, it occurs in the bank of the same branch. This rock is gray and crystalline, and its layers are of considerable thickness. The character of the rock indicates that a good quality of lime could be manufactured from it. The entire thickness of the outcrop here aggregates about fifteen feet. Again, at the ford of the Illinois River, in section 19, on the east bank, a similar exposure appears, adjacent to the road and at the base of a chert-covered bank. From Farmington, which lies in the northwest quarter of the northwest of section 26, westward to the ford of the Illinois River, in the northwest quarter of section 31, chert is of common occurrence, but it is not in sufficient quantity to depreciate the value of the land for agricultural purposes until the vicinity of the river is reached. The general appearance of the surface is similar to that heretofore described as "flat woods"—a reddish soil containing small chert fragments, and producing well both fruit and grain. The chert is exposed in these lands only in the slight hollows or washes. For the entire distance the inference is forced upon the observer that he is traversing the upper portion of

the cherty limestone from the occurrence, often at frequent intervals, of either a sandy soil or of sandy fragments, and especially is this the idea impressed upon him in section 29.

At the ford of the Illinois River, on the Farmington-Rhea's Mill road, above mentioned, the limestone forms a ledge along the banks of the river. In its general appearance and character, it resembles this rock as elsewhere described. There are cherty layers upon the upper surface of the ledge. The banks at this place are very cherty, reminding one of the chert barrens further north.

This same limestone is characteristically shown on the Fayetteville-Prairie Grove road at Walnut Grove Church, in 15 N., 31 W., in the southwest quarter of section 3, and in section 4 the great accumulation of cherty fragments on the banks of a small stream recall the chert-covered hills along Clear Creek. This is repeated in a more pronounced way less than a mile to the westward on the road from Prairie Grove to Farmington. The region in the vicinity of Prairie Grove (section 18) is underlain by the Boone chert and cherty limestone, so that chert fragments abound just north of the village. A well 75 feet and 8 inches in depth, drilled at the residence of Dr. E. G. McCormick, in the southwest corner of the southeast quarter of the northwest quarter of section 18, is said to have passed through 69 feet of limestone and chert, and 6 feet 8 inches of white sand. It was impossible to obtain samples of this so-called white sand for examination, but in all probability it was not sand in the usual sense of the word, but rather the finely broken fragments of a certain layer of the limestone, which has been encountered elsewhere, whitish in color, with a decided tendency to crumble into fragments, thus forming calcareous and not siliceous sand, as was thought by those who had seen it.

Near the line between sections 5 and 6, of township 15 N., 31 W., north of Prairie Grove, along the left bank of the Illinois River, there is a well marked bluff of gray limestone,

rather thick-bedded toward the base where it is covered by talus below, but more thinly bedded above and with numerous cherty layers. Viewed from below, it presents the appearance of a great wall. The distance from its top to the bed of the river is 50 feet. On the opposite bank a short distance down the stream, there is another bluff. Crossing the river and ascending the right bank, on the road leading from Viney Grove, through section 5, to the Farmington and Prairie Grove road, vast quantities of chert are encountered, the surface being so completely covered with it as to resemble a fall of snow.

Northwest of Prairie Grove, in 15 N., 32 W., in the southwest quarter of section 12, ten feet or more of gray thin-bedded limestone outcrops in the bank of Marr's Creek, close to the road. In this section excavations for wells show that the limestone is overlain by a gray shale.

In the southern part of 16 N., 32 W., the Fayetteville-Rhea's Mill road traverses a level or slightly rolling tract underlain by this limestone. The soil is rich, producing wheat, Indian corn, clover and grasses. Twenty years ago it was a prairie overgrown with grass, sumach and sassafras. In section 28, the Northwest Arkansas Mining and Smelting Company has put down five shafts in prospecting for lead ore. The dumps of these shafts show that they have penetrated chert principally.

West of Wedington, along the Cincinnati-Wedington road, chert is of common occurrence. In 16 N., 33 W., sections 11 and 12, the surface is rolling and flinty, producing wheat, corn and oats. Of the forest growth in this locality mention may be made of black-jack, hickory, locust, post-oak and walnut. Through sections 14 and 15 there are chert barrens to the south of the road, but to the north there is rich valley land. Continuing south from the southwest quarter of section 15, a large amount of cherty debris is encountered in descending the hill, above Moore's mill, in section 28.

The cherty limestone also occurs in the vicinity of Cincinnati. At Hiram Fulmer's residence, on the bank of Cincin-

nati Creek, at the base of a sandstone-capped hill, a well has been sunk for 18 feet through chert and a very compact and somewhat crystalline limestone. A sandstone ridge extends through Cincinnati in a northeast and southwest direction. It is safe to say that the ridge is underlain by this limestone.

In the northeast quarter of the northeast quarter of section 31, there is a feebly marked, sandstone-capped mound, an outlier of the ridge just mentioned, around which chert has been plowed up, as well as thin fragments of very fossiliferous limestone, having a metallic ring, when struck, and a peculiar odor when freshly broken.

West of the Masonic Hall and school-house at Cincinnati, in the bank of Bound's Creek, sandstone and shale, with limestone beneath, are seen dipping nearly south, at a high angle. North of Cincinnati there is a series of chert ridges between the drainage basins of the various streams flowing into Cincinnati Creek. In 16 N., 33 W., the northeast quarter of section 20, a bluff of limestone, twenty to twenty-five feet high, skirts the right bank of the creek. There are bluffs also near the north line of section 6, but they are probably in Benton county.

Southeast of Cincinnati the road to Boonsboro crosses the upper layers of the limestone near the south line of the township. South of the village, along the road to Summer's store and Dutch Mills, both chert and limestone occur. In 15 N., 33 W., the southwest quarter of section 4 and the northwest quarter of section 9, the road passes over a flat surface of gray crinoidal limestone for at least a half a mile. South of Summer's store, in section 16, fragments of both sandstone and chert appear, but there can be no doubt that the underlying rock is limestone. The well at Mr. Price's, in the northwest quarter of the northeast quarter of section 21, is in chert and limestone.

Descending from Sugar Mountain into 14 N., 33 W., limestone and chert are again encountered. Near Mr. A. H. Lit-

tle's house, presumably in the southeast quarter of section 9, two streams unite, each of which flows over a bed of solid limestone. Ascending the hill to his house, the rock becomes somewhat shaly, and soon passes into chert. Approaching the Barren Fork bottom, accumulations of chert are still apparent on the slopes and banks of the streams, as near White Rock school-house.

Chert covers the country about Dutch Mills, nor is it lost sight of until the East Fork of the Illinois River (Evansville Creek) is reached in 13 N., 33 W., sections 15 and 16, south of Greersburg. On the road, in the southwest quarter of the southeast quarter of section 9, just east of the State line, the limestone is exposed in the open country.

CHAPTER IV.

THE WYMAN SANDSTONE.

The Wyman sandstone is so named from Wyman, a station in Washington county, on the Pacific and Great Eastern Railway, near which this rock occurs. It extends along the banks of the White River, four and a half miles east of Fayetteville, and occurs in the vicinity of the Wyman school house.

Characters.—Its characters are well shown in a quarry two and a half miles northwest of Fayetteville. Here, as in several other localities, its thickness is from two to three feet, although an examination of well sections leads to the opinion that it is occasionally from six to nine feet. It is rather soft, and on a weathered surface is of a yellowish brown color, but where freshly broken its color is much lighter. It does not present the indurated appearance of many of the sandstones found at a higher level, especially those on the hills and mountains.

Position.—The Wyman sandstone in many localities separates the Boone chert and its accompanying limestone from the Fayetteville shale. The extent of this rock is as yet undetermined, but it certainly appears in widely separated localities, and for that reason is thought to be of considerable persistence.

It frequently forms a layer from two to three feet thick, interpolated just beneath the uppermost layers of the limestone, or between the uppermost layer and the black shale above. These sandstone layers are very noticeable on the banks of White River near the section corner between 8, 9, 16, 17 of township 16 N., 29 W., not far from Wyman, along the southern bank of West Fork in the same township, and on the northern bank of White River in sections 3, 4, 8 and 9.

In 16 N., 30 W., this sandstone crosses the Elm Springs road, on the line between sections 5 and 6, extending in an east and west direction. It must be admitted that a layer of its thinness is traced with considerable difficulty, and as the strata are here practically horizontal, it is only where it approaches the surface, or is exposed artificially, that its presence can be detected, and oftentimes, at best, only by loose fragments.

In the southwest of the northeast of section 7 a quarry has been opened upon the Wyman sandstone. The total thickness of the stratum at this point is about three feet, and it rests directly upon limestone. It breaks into layers of convenient thickness for building purposes, and near the surface, where exposed, is of a yellowish brown color, becoming lighter, however, beneath. Surface indications go to show that this rock extends westward through section 7, joining the sandstone area in township 16 N., 31 W. A well dug in the southwest corner of the southwest quarter of the southeast quarter of section 7 shows the following section :

1.	Soil	4 feet.
2.	Black shale	6 feet.
3.	Decomposed rock	1 foot.
4.	Sandstone, about	3 feet.
5.	Cherty limestone	8 feet.
	Depth of well	22 feet

In township 16 N., 31 W., this formation is exposed in the ditches along the Fayetteville-Cincinnati road on the line between sections 13 and 24, where it shows the characteristic light yellowish brown color. It is the prevailing rock in sections 13 and 14, the southern half of 11 and a portion each of the north half of 23, the north half of 24, the west half of 10 and 15 and the north half of 12 of this same township and range.

The following well sections compiled by Mr. N. F. Drake would indicate that the sandstone in this township is considerably thicker than in the other localities examined, and that it

here covers a greater area than elsewhere in the region examined.

(1.) Section of a well in 16 N., 31 W., the northeast quarter of the southeast quarter of section 11.

1.	Soil and clay	1 foot.
2.	Soft yellow sandstone	4 feet.
3.	Red clay	3 feet.
4.	Blue and gray limestone	8 feet.
5.	Chert	8 feet.
	Depth of well	24 feet.

(2.) Section of a well in 16 N., 31 W., the southwest quarter of the northwest quarter of section 14.

1.	Soil and yellow clay	6 feet.
2.	Alternate layers of sandstone and clay	10 feet.
3.	Hard blue limestone	5 feet.
	Depth of well	21 feet.

(3.) Section of a well in 16 N., 31 W., the southeast quarter of the northeast quarter of section 15.

1.	Soil and clay	20 feet.
2.	Soft yellow sandstone	10 feet.
3.	Limestone and flint	2 feet.
	Depth of well	32 feet.

(4.) Section of a well in 16 N., 31 W., the southwest quarter of the southeast quarter of section 11.

1.	Soil and yellow clay	4 feet.
2.	Sandstone	3 feet.
3.	Red clay	2 feet.
4.	Blue and gray limestone	12½ feet.
	Depth of well	21½ feet.

(5.) Section of a well in 16 N., 31 W., the southwest quarter of the northeast quarter of section 12.

1.	Soil and clay	4 feet.
2.	Soft yellow sandstone	4 feet.
3.	Yellow clay	4 feet.
4.	Soft yellow sandstone	2 feet.
5.	Clay	3 feet.
6.	Limestone	9 feet.
	Depth of well	26 feet.

The Wyman sandstone also occurs on the Fayetteville road east of Farmington, along the line between sections 23 and 26, and undoubtedly extends across the first named section, being in all probability a continuation of that found on the south side of the Fayetteville-Cincinnati road before mentioned. West of Farmington the sandy character of the soil, together with the fragments of sandstone, indicate the presence of a thin layer of this formation.

This sandstone appears also in the limestone area of 17 N., 30 W., in several localities: in the southeast quarter of section 14, in the center of the north half of section 25, in the flat area skirting the foot of the mountain in section 36, and in the road near the half section corner between sections 33, 34, from which point, judging from surface indications, it passes northeastward through the north half of section 34, bordering the valley underlain by the Fayetteville shale, to the railway.

CHAPTER V.

THE FAYETTEVILLE SHALE.

Characters.—In Washington county the Fayetteville shale is the principal formation lying between the Boone chert and the Archimedes limestone. It receives its name from its occurrence in the valleys about Fayetteville, especially those of the West Fork of White River and its tributaries. While the prevailing color of the Fayetteville shale is black, as in most instances where it has been recently exposed, it may be of a bluish or even a yellowish brown color. From a lithologic standpoint, however, it cannot be distinguished from any other black shale, its variability in color upon exposure to the air, the presence of concretions, its breaking up into prismatic fragments, are all common to other similar rocks.

In its general appearance the Fayetteville shale resembles quite closely that overlying the Pentremital limestone, which is coal bearing, and for which it might easily be mistaken. There is, however, this difference: while the one is almost, if not completely barren of fossils,* the other, especially in the layers near the coal bed, is usually very fossiliferous. Certain layers of black limestone are found northeast of Fayetteville in close proximity to the Boone chert, which are, however, unusually rich in brachiopod remains, especially Spirifers. As a rule it can be easily recognized by its position between the two limestones mentioned.

Localities.—The following is a list of the localities in Washington county at which the Fayetteville shale is exposed:

In the West Fork valley.
In township 16 N., 30 W.
In 15 N., 33 W.
At the foot of Bell Mountain.

*Two specimens of *Orthoceras*, said to have been found in this shale, have been seen by the author.

In the vicinity of Fayetteville.
In Sulphur Spring Mountain.
At the base of Millsap's Mountain.
In the valley of Town Branch.
At the base of Kessler Mountain.
In 15 N., 31 W.
In 15 N., 32 W.
At the foot of Wolf Mountain.
On Cane Hill.
In 16 N., 32 W.
Wedington Gap.
In 16 N., 33 W.
In 14 N., 33 W.
In 13 N., 33 W.
At the ford of Evansville Creek.
In 16 N., 29 W.
In the valleys of the Main, Middle and West Forks of White River.
In 17 N., 29 W.
In 17 N., 28 W.
At the base of Gilliam Mountain, near Goshen.
In 17 N., 29 W., west of White River.

In the valley of the West Fork of White River the Fayetteville shale appears in 15 N., 30 W., a mile and a half north of the village of West Fork, and continues northward, covering an area varying in width from half a mile to four miles, at the line between 15 N., 30 W., and 16 N., 30 W. It is the underlying rock of fully three-quarters of 16 N., 30 W., appearing to the least extent in the northeast quarter of that township and range. Rising above this shale are numerous elevated points, as Brooks, Baxter, Miller, Kessler, Washington, Archias and Millsap's Mountains, and the island-like masses seen to the south and west of Fayetteville.

The Fayetteville shale occurs both north and south of University Hill, and south of the following elevations: the bench upon which the business portion of Fayetteville stands, East Mountain and Pierce Mountain, and the sandstone area between them. It also occurs beyond the high ground immediately north of Fayetteville and enters the corporation along the line of the St. Louis and San Francisco Railway.

In the southwest quarter of section 24, Sulphur Springs Mountain is a curious conical hill of Fayetteville shale, attaining a height of 150 to 175 feet above the West Fork River bottoms. This hill is almost entirely if not quite composed of shale, and is furrowed by ravines from its summit to its base, in consequence of which its structure is well shown.

In the hill just mentioned, the shale is black at its base and brownish higher up, while the slope and summit are covered with loose fragments of sandstone.

In section 18, around the foot of the northeastern slope of Millsap's Mountain, there is a great exposure of black shale whose outcropping gives a weird appearance to the landscape; for, owing to the want of soil, there has been but a scanty growth of vegetation, consisting now of scattered, dead and dying scrub oaks. Beginning at the small stream near the northeast corner of the northeast quarter of the northwest quarter of this section, the black shale continues for 60 feet up the mountain side, where it is succeeded by a brownish or a drab concretionary shale. Black shale is also exposed in the northwest quarter of section 19 at the base of the same mountain, where the Farmington and Cincinnati roads fork, and for some distance along the latter road.

In the valley of Town Branch, south of Fayetteville, there are numerous exposures of the Fayetteville shale which, on account of its blackness, has led to the popular belief that it contains a bed of coal. There may be carbonaceous layers an inch or two in thickness in this shale, but there is no evidence whatever of the existence of a bed of coal of a workable thickness.

The Fayetteville shale is also exposed at the base of Kessler Mountain, on the west side, in 16 N., 31 W., sections 24, 25 and 26, and underlies portions of sections 35 and 36 of the same township. At the southern extremity of the mountain it is well shown along the road in 15 N., 31 W., the northeast quarter of section 1. It also occurs along the Fayetteville-Prairie Grove road in the northeast quarter of section 3, but as the country is comparatively flat and unbroken, the exposures are but inconspicuous outcrops. After an interval of Boone chert and cherty limestone, this shale is again met on the same road at the ford of the Illinois River in section 9. A short distance below, at the ford of the Prairie Grove and

Farmington road in section 8, it is exposed in a bank about 10 feet high, resting directly upon a limestone bed of the Boone chert group, which appears near the water's edge. The Wyman sandstone does not appear in this section.

In 15 N., 32 W., this shale appears in the northeast quarter of section 23, at the foot of Wolf Mountain, where the road from Prairie Grove to Boonsboro turns to the southwest. At this place it is covered by sandstone debris. A well on J. P. Bennett's place, in the southeast quarter of the northeast quarter of this section, passes through the following:

Clay soil	3 feet.
Loose sandstone	5 feet.
Black shale	10 feet.
	18 feet.

The road crossing this section diagonally from northeast to southwest, leads up the mountain side and descends in the southwest quarter. Here again the shale is encountered on the hillside above Liberty school-house. In making the ascent to the first bench of the Cane Hill Mountain, which is 140 feet above Prairie Grove, the road passes over a clay in the northeast quarter of section 27, which, when wet, renders it almost impassable. This clay has probably resulted from the decomposition of the Fayetteville shale, although it is here concealed beneath the thickly strewn sandstone fragments.

Ascending the mountain from the ford of the Illinois River near Ladd's on the Ladd's Mill-Cincinnati road, the black Fayetteville shale occurs in the Wedington Gap, 230 feet above the river. At this level it is in the form of loose fragments, which, as is characteristic in this region, have worked down the mountain side and mingled with the debris of the Boone chert and the sandstone that usually overlies it. At the height of 260 feet, in 16 N., 32 W., the northeast quarter of section 5, $3\frac{1}{2}$ feet of very black shale is exposed in the road. Still ascending, shale is soon met again and continues to the summit of the gap, where there is a large exposure 300 feet

above the Illinois River. Descending on the west side of the mountain, the black shale occurs above the cherty limestone, in the southwest corner of section 6, half a mile northeast of Wedington.

On the road from Cincinnati to Boonsboro, near the foot of the Wedington Mountain, soon after leaving Cincinnati Creek, and not far from the line between townships 15 N., 33 W. and 16 N., 33 W., the upper layers of the Boone chert and cherty limestone appear. Above the limestone, the slope is covered with sandstone debris, yet the occurrence of small pieces of black shale is an indication of the presence of the Fayetteville shale in this locality.

Again in 15 N., 33 W., the northwest quarter of section 9, at the foot of an isolated elevation known as Bell Mountain, and adjacent to the road from Cincinnati to Dutch Mills, several exposures of Fayetteville shale are visible. These patches present the usual characteristics of thinly laminated, argillaceous rocks: the jointed structure, and the disintegration under atmospheric influences, into small thin fragments. The thickness of the shale visible is 30 feet, but it is probably thicker, for both the top and the bottom of the formation are covered with loose fragments of sandstone derived from the disintegration of the sandstone beds of the mountain above.

On the direct road from Cincinnati to Dutch Mills, black shale is met, above the cherty limestone, in descending the mountain in the northern part of 14 N., 33 W., not far from the line between sections 3 and 4.

In 13 N., 33 W., the Fayetteville shale occurs in the vicinity of Evansville, at the ford of Evansville Creek, on the line between sections 15 and 16, three-quarters of a mile north of the town. The outcrop here dips eastward at an angle of about 5°. Near Littlejohn's Mill, at Evansville, thin-bedded sandstone appears 70 feet above the creek, which indicates the approximate thickness of the shale deposit.

In 16 N., 29 W., this shale skirts Round Mountain and the foot-hills of the ridges bordering Main Fork. It is the prevailing rock in the valley of Middle Fork, and underlies a considerable area in the West Fork valley, adjoining that already described in 16 N., 30 W. It also continues up the Middle Fork valley into 15 N., 29 W., where it is exposed in small streams and up the Main Fork valley into 15 N., 29 W. and 15 N., 28 W. At Elkin's station (Hood Post-office), well sections show that there are from twelve to twenty feet of black shale resting upon the Boone chert and cherty limestone. From this point there are frequent exposures along the river banks to Durham, and even beyond that town.

This Fayetteville shale, in 17 N., 29 W., forms a narrow band extending nearly east and west through the centers of sections 23 and 24, projecting southward, however, in the west half of 23 to the river. It now follows the course of the stream to the fault, near the corner of sections 14, 15, 22 and 23. From the eastern half of 24, it may be traced in a southeast direction into 17 N., 28 W., the south half of section 19.

At the foot of Gilliam Mountain, in the last named township, there is an exposure of Fayetteville shale about fifty feet thick. The mountain side is covered with sandstone debris, and some of the larger flat slabs now rest on the shale.

On the west side of White River, the outcrop of this formation follows a general north-northwest course, through the center of 17 N., 29 W., skirting the sandstone ridges and the bases of Harp, Price and Webber Mountains. Shale also appears in the ravines extending back from the White River valley near the southern boundary of this township, in sections 32, 33 and 34.

In the western part of the township, this formation again appears in sections 19 (extending into section 20), 30 and 31. From this point it might be expected to continue in a northeast direction to the vicinity of Price Mountain, but the hard rocks are hidden by the surface clays. The area of shale, however,

continues westward into 17 N., 30 W., sections 24 and 25, thence in a southwest direction, occupying the area already given in describing the boundaries of the Boone chert and cherty limestone in that township.

Thin beds of black limestone occur in the lower portions of the Fayetteville shale at the base of the mountain in 15 N., 30 W., section 3, and black concretionary limestone layers are reported by Mr. Harris as being by no means infrequent in 16 N., 29 W., and 17 N., 29 W., especially within twenty-five feet of the cherty limestone.

"In the northwest quarter of the northwest quarter of section 27 of the latter township, on G. W. Bowman's place, this black limestone is represented by a layer about a foot in thickness. In it are small cavities lined with calcite crystals, and containing a small quantity of petroleum."—HARRIS.

In 17 N., 29 W., section 5, a thin bed of coal of no value was struck in the bottom of a well near the junction of the half section and township lines. Having been dug into in many localities in this and the township south of it (16 N., 29 W.), it is safe to say that the Fayetteville shale has been seen from top to bottom, and that, so far as these townships are concerned, it is not coal-bearing.

Furthermore, a careful examination of many other localities in the county shows that the conclusion regarding a single township, admits of a more extended application, viz.: That the Fayetteville shale, in so far as Washington county is concerned, is not a coal-bearing formation.

A BLUFF OF THE BATESVILLE SANDSTONE AT WEST FORK.

CHAPTER VI.

THE BATESVILLE SANDSTONE.

Character.—The Batesville sandstone is the next formation above the Fayetteville shale described in the preceding chapter. This is a coarse sandstone varying somewhat in color from gray to brown.

In thickness it varies from 10 to 60 feet. It is sometimes more or less massive, but it usually forms beds from a foot to three or four feet thick, but these individual beds often vary in thickness within short distances. In places the rock is false-bedded. Wells dug in this sandstone usually yield an abundance of excellent soft water.

Position.—The Batesville sandstone either immediately underlies the Archimedes limestone, or it is separated from it by the Marshall shale. The former condition undoubtedly prevails about Fayetteville, and in one locality, at least, half a mile west of the Arkansas Industrial University, the contact of the limestone with the sandstone may be seen. Usually, however, the outcrop of the sandstone is hidden from view by the debris falling from the overlying rocks.

In the bluff on Harp's Mountain, eight miles northeast of Fayetteville, this formation, according to Mr. Harris, is in the form of a massive sandstone sixty feet thick, but the Archimedes limestone does not appear in this locality.

In the northeastern part of the county, in the region of the White River, at Johnson's bend, according to the same authority, the Archimedes limestone does not appear, and the Batesville sandstone and the Washington sandstone are merged into one.

Exposures.—At the town of West Fork a sandstone bluff occurs at the ford of the Fayetteville road, in 15 N., 30 W., the southeast quarter of the southeast quarter of section 32. The

strata here rise from the water's edge to a height of 30 feet or more. The lower beds have been eroded by the river, and the upper and harder ones form overhanging shelves. Thirty feet, however, does not represent the total thickness of the sandstone, which certainly occurs 20 feet or more above the edge of the bluff, from which there is a considerable upward slope to the Archimedes limestone.

On the left bank of the West Fork, beginning in the northern part of the southwest quarter of the southeast quarter of the same section, this sandstone again occurs as a bluff, and so continues for more than half a mile down the river.

On the west side of the railway (St. L. & S. F. Ry.), which follows the course of West Fork to within a mile of Greenland station, a bluff of Batesville sandstone begins near the center of section 29. It first appears on the north side of a small stream, where it is about 12 feet in thickness, massive and of a brown color where weathered, but gray upon a recent fracture. Large masses have here become detached and have fallen away from the bluff which forms the edge of a sandstone bench. This bench may be traced along the railway for at least three miles, and in the hollows opening into the West Fork valley, the small streams form water-falls in passing over it. As one proceeds northward, the sandstone takes a constantly higher position above the river. Near the center of section 29, it is about 40 feet above the water level, while near the north line of the same section it is much higher and underlain by a concretionary shale. Of course the fact that the river is descending is recognized, but at the same time the sandstone is gradually approaching the Archimedes limestone.

On the east side of West Fork valley, the Batesville sandstone may be traced from the bluff on the river, in section 32, in a meandering course, around the hills and mountains, in a general northeast direction, to section 1. In sections 21 and 22 it borders the large ravine between Round Mountain and White Oak Mountain, and extends back from the West

THE BREAKING UP OF A LEDGE OF BATESVILLE SANDSTONE ONE AND A HALF MILES NORTH OF WEST FORK.

Fork valley for over a mile. In sections 9 and 10 it borders a ravine extending into the mountains for half a mile, at the head of which, near Flat Rock school-house, in the southwest corner of the northwest quarter of the southeast quarter of section 10, the sandstone shows an exposure about 12 feet thick, overlain by brownish yellow shales forming a bench. Again, in sections 2 and 11 it penetrates a deep branching ravine between Brinson Mountain and White Oak Mountain.

In 15 N., 30 W., the east half of section 17, the sandstone bluff occurs 50 feet below the Archimedes limestone. It is probable that an arenaceous shale intervenes as indicated by the broad bench and sandy fragments.

In 15 N., 29 W., the northwest and southwest quarters of section 27, and in the northwest quarter of section 34, in the valley of Middle Fork, the Batesville sandstone is highly developed. In section 27 it forms a well marked bluff along the river a considerable distance above which the Archimedes limestone, with its vertical face and massive fragments, showing this formation to have a thickness of not less than 50 feet. At Carter's store the sandstone is exposed in the bottom of the river, the course of which is against the edges of the slightly dipping strata.

Though it exists in 16 N., 30 W., the sandstone usually occurs in such inaccessible positions that in most instances information regarding it is difficult to obtain. Moreover, as the overlying Archimedes limestone frequently forms a bluff around the hills, the outcrop of the Batesville sandstone is covered by an accumulation of fragments from the beds above. In Fayetteville a well dug near the center of section 16 passed through the Archimedes limestone and penetrated the underlying sandstone. The section is as follows :

Soil and clay	10 feet.
Solid limestone	20 feet.
Soft sandstone	2 feet.
Depth of well	32 feet.

At the depth given, there being an abundance of water, digging was suspended, and the thickness of the sandstone not ascertained.

In 16 N., 29 W., and 17 N., 29 W., this formation is extremely variable in thickness. In Harp's Bluff, in section 10 of the last named township, it is in the form of a massive sandstone, and is at least sixty feet in thickness.

At Mr. J. P. Carnahan's saw mill, south of Boonsboro, 14 N., 32 W., southeast quarter of the southeast quarter of section 8, the Batesville sandstone is exposed in the banks of Jordan Creek. The upper layer of this outcrop is quite hard, and about two feet thick, breaking off in large slabs, while beneath the outcrop it is weathered and flaggy. A fine illustration of the great power of growing roots and their effect upon rocks is shown at this point. A hackberry tree had sprung up in a fissure and its roots penetrating a seam on the plane of stratification, it had gradually separated a slab, twenty feet long, twelve inches from its original position. The high water, during a storm in the summer of 1889, carried the slab down stream, leaving the roots of the tree exposed to view, spread out over the lower portion of the sandstone stratum. From the level of Jordan Creek to the Archimedes Limestone at the mill, is about forty feet.

From this point sandstone may be traced along the left bank of Jordan Creek through 14 N., 32 W., sections 17 and 18. A bluff about ten feet high, is well shown near the half section line, east and west, through section 18, just north of the road from New Town (Clyde Post-office) to Dutch Mills. In the northwest quarter of this section the succession of the rocks is as follows: cherty limestone at the water level, followed in order by the black Fayetteville shale and the Batesville sandstone, capped by a bluff eight to ten feet in height, the top of which is 200 feet above Jordan Creek. This bluff forms the escarpment of a bench which gradually slopes to the Archimedes limestone, south of the half section line.

Batesville sandstone is the prevailing rock on the road leading from New Town, through section 20, though at the spring near Milton Cox's house, fragments of Archimedes limestone appear, showing that stratum to be near at hand. At the base of the main ridge of the Boston Mountain, this road passes some distance up the bed of Fly Creek, near the line running east and west between sections 21, 22, 27 and 28, at a level below the Archimedes limestone, over sandy fragments and a sandy soil. While the Batesville sandstone is, of course, to be expected at this horizon, yet, as a matter of fact, the origin of much of the debris is to be looked for at a higher level.

South of the Boston Mountains, in the Cove Creek valley, 13 N., 32 W., near the line between sections 14 and 23, a floor of hard quartzose sandstone dips into the creek. This rock is thin-bedded and its upper surface has been cracked or broken in long seams at right angles to the plane of stratification. It underlies the Archimedes limestone which forms a bluff in plain view on the right side of the valley. Its peculiar characters may be due to the displacement which appears at Mr. Clanton's, a short distance beyond, in section 23.

Farther west, at Evansville, near Littlejohn's mill, sandstone probably ten feet thick is also exposed between the Fayetteville shale and the Archimedes limestone.

THE MARSHALL SHALE.

Characters.—The Marshall shale is a black and more or less bituminous shale, but it has no marked characters by which it can be distinguished from other bituminous shales, aside from its stratigraphic position between the Batesville sandstone below and the Archimedes limestone above.

It can scarcely be considered one of the important geologic formations of Washington county. Indeed, it is sometimes entirely wanting, its greater development being further east. The formation is named from the shale mountain just east of Marshall, in Searcy county.

Exposures.—South of Fayetteville the Batesville sandstone is separated from the Archimedes limestone by the Marshall shale. In township 15 N., 30 W., this shale is more or less developed, occupying its usual position above the Batesville sandstone.

In the southeast quarter of section 3 the sandstone exposed is about 10 feet thick, and is separated from the Archimedes limestone by shales.

A well in the southwest quarter of the southwest quarter of section 20, at a level below the Archimedes limestone, penetrated 8 feet of Marshall shale before reaching the Batesville sandstone.

A little south of the center of section 29 the succession of rocks appears to be as follows: At the height of 35 to 40 feet above the surface of West Fork, the Batesville sandstone appears, the edge of the stratum presenting a thickness of from 8 to 10 feet. Forty or fifty feet above it the Archimedes limestone appears, the interval between these two rocks being undoubtedly largely occupied by the Marshall shale. In the vicinity of the town of West Fork the Marshall shale attains a thickness of from 40 to 80 feet. It thins out to the north until the sandstone and limestone are in contact.

CHAPTER VII.

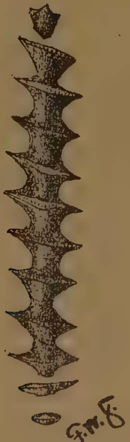
THE ARCHIMEDES LIMESTONE.

The Archimedes limestone, as its name implies, is characterized by the easily recognized fossil Bryozoa of the genus *Archimedes,* though it contains many fossils besides this, especially corals, crinoids and brachiopods. Unlike the limestones of the Boone chert, it is not the bed-rock over a large area, nor

Archimedes as it occasionally appears on a weathered surface. (Natural size.)

does it contain much chert. Generally speaking, this limestone is of a light gray color, fossiliferous, and from 25 to 40 feet thick. Its greatest development is in the north face of the Boston Mountain range, and in the spurs and outliers of those mountains, where it enters conspicuously into the bench and bluff topography. It thins out to the north, and in the vicinity

of Fayetteville assumes different characters. At the base of East Mountain, three-quarters of a mile from that town, it is shaly, has a reddish brown tint when weathered, and, although very fossiliferous, the *Archimedes* are small. The impurity of the limestone is further shown by the presence of numerous pebbles, forming a sort of conglomerate, above which there are at least two feet of pebbly shale. Dark bluish pebbles are reported by Mr. Harris to occur in the upper layers of this limestone four or five miles northeast of Fayetteville. According to the same observer, seven and a half miles northeast of Fayetteville the limestone has degenerated into a calcareous layer underlain and overlain by flaggy sandstone. That this calcareous layer represents the Archimedes limestone is shown both by its position and by the presence of the characteristic *Archimedes.*



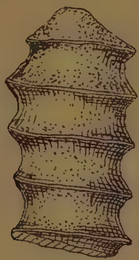
Spire of Archimedes. Weathered specimen.
(Natural size.)

From a topographic standpoint this limestone is quite important, as it not infrequently gives outline to mountain benches and spurs. In most cases, either alone or in connection with the overlying shale and sandstone, it presents a ver-

tical face from 15 to 40 feet in height—a conspicuous topographic feature, which is most pronounced in the north facing outliers of the Boston Mountains.

Excellent examples of this feature are to be seen in the 15 N., 30 W., in the vicinity of the village of West Fork.

Localities.—The following are the principal occurrences of the Archimedes limestone in Washington county:



Spire of Archimedes. Weathered specimen. (Natural size.)

In 15 N., 30 W., near the village of West Fork, west of railway.

On Bald Mountain, 15 N., 30 W., in section 5.

East of the West Fork of White River, in the same township.

In 14 N., 30 W.

Bluffs on the east bank of West Fork.

In 16 N., 29 W.

In the ridge between West Fork and Middle Fork.

In 15 N., 29 W.

Fincher's Cave.

Bluffs near Carter's store.

In the ridge between Carter's and Durham.

In 15 N., 28 W.

Bluffs on the east side of the Main Fork valley.

In the vicinity of Durham.

In McCullom's Mountain, 16 N., 30 W.

In 16 N., 30 W.

At Fayetteville and in its vincinity.

In Kessler Mountain.

In East Mountain.

In 16 N., 29 W.

In the ridge between Middle Fork and Main Fork.

In 17 N., 29 W.

In 15 N., 32 W.

On Cane Hill.

In 14 N., 32 W.

At Boonsboro.

At Bean's old mill, in section 5.

At Brunk's, in section 28.

At Morrow's, in section 36.

In 17 N., 33 W., at Evansville.

Local details.—This widely known limestone is well developed in the country south of Fayetteville, where it usually forms escarpments or bluffs. In 15 N., 30 W., on the west side of the West Fork, several peculiar spurs project eastward from sections 30 and 31.

The southernmost of these terminates in a high bluff skirting the river valley near the center of section 32. Below this bluff and 15 feet above the water level, is the bed of the St. Louis and San Francisco Railway. At a still lower level in the river, the Batesville sandstone appears, thin-layered and dark colored. Ascending from this point immediately on the west side of the track there are masses of limestone which have fallen from the cliff above. Following these fragments there is a slope covered with loose shale which has also fallen from the bluff (see Washington shale, chapter IX). The base of the limestone is seventy feet above the river, while its top is 105 feet, showing the Archimedes limestone at this point to be at least 35 feet thick. The rock here exposed is very massive, and it presents an almost perpendicular face.

The second spur extends eastward for about three-quarters of a mile nearly on the line between sections 30 and 31, terminating in the northwest of section 32. It is peculiar on account of its extreme narrowness; its greatest width scarcely exceeds 150 yards, while for much of the distance it is considerably less. At its extremity it presents the usual perpendicular face of 25 or 30 feet, seamed and fissured, at the base of which great masses lie partly buried in the soil. The layers in the cliff on the south side were undermined in many places, and other large blocks will soon be added to those already on the ground. This exposure furnishes fine specimens of the fossil *Archimedes*.

A quarter of a mile further north a similar and parallel spur extends eastward through the southeast quarter of section 30 and terminates in the southeast quarter of the southwest quarter of section 29. North of this spur a broad ravine

intervenes, no limestone appearing near the river (West Fork) for half a mile, excepting a small mass capping a hill near the center of section 29. In the northwest quarter of the northeast quarter of this section the Archimedes limestone is tabulated and the harder upper layers project outward for 15 or 20 feet beyond the softer layers below. From this point the bluff meanders in a general northern direction through sections 20, 17 and the southern half of 8. One of the short deep ravines that borders the ridge occurs in the northern half of section 20, two in section 17, and one in section 8. In them there are bluffs made by the Archimedes limestone, and others made by the Batesville sandstone at a lower level.

Near the center of section 8, the limestone outcrop is covered for a short interval, but soon reappears in the southwest quarter of the same section, at first in fragments buried in the soil and later in a bluff near the line dividing the southwest quarter and southeast quarter of the southwest quarter of the section. From this point it is traced southward into the northeast quarter of the northwest quarter of section 17. Here the characteristic fossils prevail, and here, too, as is common in limestone districts, a large spring issues from a cave. A short distance farther south, the surface exposures are lost sight of.

West of Greenland station (Staunton Post-office), which lies in the northwest quarter of section 9, in the West Fork valley, a broad ravine breaks through the line of bluffs, and the Archimedes limestone next appears along the base of a small hill in the northwest quarter of section 7. A quarter of a mile northward it appears along the Van Buren road in the southeast quarter of section 6. It can now be traced through the southwest quarter of section 5, and then northward to the township line, north of which it skirts a long spur extending from McCullom's Mountain, through section 32 into the southwest quarter of the southeast quarter of section 29, both in 16 N., 30 W. Along the east side of this spur, the limestone

is found at the base of the bluff, at a height of over 150 feet above the railway track, and, as usual, the point of contact with the underlying rock, is concealed by debris.

On the west side of this spur, the limestone is also exposed. In 16 N., 30 W., not far from the northeast corner of the southeast quarter of section 31, there are some limestone slabs which have weathered in a most beautiful manner. The softer matrix in which the fossils were originally imbedded, has been dissolved, leaving crinoid stems, large and small, and other remains standing out in relief.

After entering a narrow gorge in the northeast quarter of the southeast quarter of this section, the outcrop crosses the "old wire road," or Fayetteville-Van Buren road, near Cato's shop, after which it may be traced by a sinuous course along the foot-hills at the base of Kessler Mountain and its spur extending to the northeast, known as Washington Mountain

In 15 N., 30 W., the southeast quarter of the northeast quarter of section 5, Bald Mountain, is capped with large masses of typical Archimedes limestone. To the observer ascending, these fragments have the appearance of a low bluff or wall, the edges only being in view. The summit of this hill is about 140 feet above the valley. Its northeast slope is a mass of shale, which now supports a stunted growth of trees. Formerly this is said to have been entirely destitute of vegetation, hence the name of the mountain.

On the east side of the West Fork valley in 15 N., 30 W., the Archimedes limestone is also well shown. A striking though characteristic bluff occurs near the northwest corner of the southwest of section 33, half a mile northeast of West Fork village, on the right side of the road leading to Fayetteville. At its base are large detached fragments, some in their normal horizontal position, others inclined, and others again, completely on end. Most of them, however, are still in a horizontal position, though many, upon breaking away, have rolled or slid down the slope below, for a hundred yards or so,

and are, of course, more or less inclined. Here they stand exposed to the weather, and disintegration and decay taking place slowly along the lines of stratification and lamination, has left the harder layers standing out in relief. In some instances the upper layers have become almost completely detached, but still rest perched upon the tops of the blocks. The cause of the breaking away of these large masses is at once apparent: while the uppermost layers are thick and hard, the lower ones are soft, easily affected by the weather, and disintegrate readily. In this manner the bluff is undermined and new blocks are added to those already on the ground. Near the top of the cliff there is a massive layer ten feet thick, while beneath it, most of the layers are comparatively thin. Great fissures, too, extend backward from its face, and occasionally a large mass has become almost detached, and overhangs in a threatening manner. The limestone here is of the usual gray color, although among the debris are fragments of a lighter color. The measured height of this bluff is forty feet. From the southwest quarter of section 33, the outcrop has been traced by an exceedingly irregular course, owing to the deep ravines penetrating the mountains, into the northeast quarter of section 1.

Near the township line, on the south of section 33, there is a coarse, reddish layer, without the fossil *Archimedes*, and presumably separated from the main mass of limestone by from six to eight feet of shale.

Twenty rods south of the corner of sections 27, 28, 33 and 34, there is a fine cliff of this limestone facing the north. The exposure has a thickness of from thirty to thirty-five feet, and appears to grade through alternating sandy and calcareous layers into the overlying sandstone. The occurrence of an upper, reddish and hard layer was also noted here.

Near the center of the southeast quarter of section 28, it has a thickness of over fifty feet. At this point, a stream of water issues from a cave near the bottom of the formation, which has been penetrated for 200 or 300 feet. *Archimedes*

are abundant, and in a large block a short distance east of the cave entrance an *Orthoceratites*, twenty inches long by five inches wide, was found. Above the limestone there are sandy shales, with outcrops of dark calcareous fossiliferous layers.

There is a cave with a perpendicular entrance near the west line of the northwest of the northwest of section 27. The passage is through overlying sandy layers for twelve feet, and then through the Archimedes limestone for twenty-three feet, after which it traverses the latter.

A cave, also having its entrance in sandstone, occurs in the north face of a bluff in 15 N., 30 W., the southwest quarter of the southwest quarter of section 24. From the mouth it descends rapidly with several windings for about 50 feet to the bed of a subterranean stream flowing in the shale that underlies the Archimedes limestone. A short distance below the limestone is a bed of coal, an inch or two in thickness, and underlain by black shale.

As a complete section of this limestone rarely occurs, on account of the debris which accumulates at the base of its bluffs, all data relating to its exact thickness are of interest. It is worthy of mention, then, that in the northwest quarter of the northwest quarter of section 23, Mr. Crozier measured a bluff which had a thickness of 42 feet. A thickness of over 25 feet is shown in the bluff in the northwest quarter of the southwest quarter of section 1. The rock is here fissured and cavernous, with a sandstone capping, although the layers immediately joining the limestone are flaggy and even shaly.

CHAPTER VIII.

THE ARCHIMEDES LIMESTONE—*Continued.*

Southeast of the village of West Fork, in 14 N., 30 W., the west half of section 4, the Archimedes limestone forms a conspicuous bluff three-quarters of a mile long, extending in a nearly north and south direction, along the right (east) bank of the West Fork of White River. For a portion of this distance the cliff is not less than 30 feet high, and almost perpendicular. In places it approaches close to the water's edge, the confused mass of fragments and blocks almost obstructing the narrow passage between it and the river. Northward the bluff increases in height, being about 125 feet above the level of the West Fork at the ford of the Fayetteville-West Fork road, 15 N., 30 W., in the southwest of section 32. This elevation is due partly to the inclination of the valley towards the north, and partly to a low south dip of the rocks.

On the west side of the valley, west and south of the village, the limestone bluffs are more broken and the outcrops follow a rather sinuous course from the northwest quarter of the northwest quarter of section 5 to the southeast quarter of the northeast quarter of section 8, 14 N., 30 W. Near the Masonic building, in the southeast quarter of the northwest quarter of section 5, material for the burning of lime has been quarried from a bluff against which a kiln has been built. The rock here is a hard, gray limestone showing rather thick layers —one measured over 31 feet in thickness—but with a laminated structure.

The road to Billingsly (Moffit Post-office) leaves West Fork village on the township line, and bears to the southwest near the northwest corner of section 5. At this point the limestone appears about 100 feet above the water at the ford of the Fayetteville road already mentioned. Some of the fossils

(*Archimedes*) at this exposure are very large, one of them measuring 7 inches in length.

Continuing to the northeast from 15 N., 30 W., section 1, the Archimedes limestone has been traced into the high lands in the southwest part of 16 N., 29 W., lying between the West Fork and the Middle Fork of White River. Near the center of section 29 the outcrop bends southward and courses along the western escarpment of the Middle Fork valley into 15 N., 29 W. Its characteristics are similar to those already given, viz.: a thick bed of gray limestone forming, in many instances, bluffs, with the usual accumulation of large cubical blocks or masses. Such a bluff occurs in the northeast quarter of the southeast quarter of section 7. Here a thick exposure of limestone faces the south. The rock is gray and compact and the fossil *Archimedes* is found in the greatest abundance. Near the base of the cliff is the entrance to Fincher's Cave, a cavern of considerable extent, the largest explored in the area examined. The main entrance is large and of sufficient height to allow the explorer to walk erect. In the roof are crinoid stems, *Archimedes* and cyathophylloid corals, the latter cut in sections in many directions, affording fine specimens for the study of structure. An examination at numerous points shows the limestone to be very fossiliferous in those parts exposed in the cave. The main cavern can be followed for over 1300 feet from the entrance, and by crawling the exploration may be carried much farther. Two branches have also been explored for 300 or 400 feet, when they become very low. As in other limestone caves there are subterranean streams, covered water-ways, stalactites and stalagmites, and cave-earth.

The bluff of Archimedes limestone back of Carter's store in 15 N., 29 W., near the line between sections 27 and 34, presents a face from 25 to 30 feet high. The limestone is here more shaly than usual. A thick layer has the peculiarity

elsewhere noticed, of breaking up into irregular, angular fragments.

On the west bank of Middle Fork, near Carter's, there are high limestone cliffs. Frequently the layers at the base have wasted away, leaving the solid portion of the bluff projecting several feet. The lower and weathered layers have, as in the exposure just mentioned, broken up into angular fragments which in themselves are of hard, gray limestone, showing a conchoidal fracture. The Archimedes limestone is here 40 feet thick, overlain by a conglomerate a foot thick, a pebbly shale a foot and a half thick, followed by a bed of shale of about the same thickness, passing into flagging and sandstone, which continues to the top of the bluff, a distance of about 20 feet.

The road from Carter's Store, on Middle Fork, to Durham, on Main Fork, passes from the Batesville sandstone over the Archimedes limestone on to Washington sandstone, and then descends into the valley of Main Fork over these rocks in the reverse order. The limestone bluff southwest of Durham, in 15 N., 28 W., the northwest quarter of section 30, is 30 feet high. In fragments at its base brachiopods of the genus *Productus* occur in large numbers.

On the right bank of Main Fork the Archimedes limestone forms a heavy bluff extending diagonally through 15 N., 28 W. On David Lewis' land, on the river above Durham, and not far from the county line, the bluff has recently fallen. Here the debris is piled together in the greatest confusion. While the same phenomena have been noted along the limestone bluffs in many parts of the county, in no other locality has the falling away of the bluff been of so recent an occurrence, or of sufficient magnitude to disturb the inhabitants.

In the region immediately south and west of Fayetteville, in 16 N., 30 W., this limestone outlines the crowns of numerous hills, usually occurring well up the slope, and in many instances forming bluffs, either alone or in connection with

the overlying rocks. On Baxter Mountain it forms several bluffs. One of these, in 16 N., 30 W., appears near the southwest corner of the southeast quarter of the southeast quarter of section 28, passing into the northeast quarter of section 33. The face of this bluff at its highest point measures 26 feet. Among the fossils are *Archimedes* and other bryozoans, cyathophylloid or cup corals, crinoid stems and brachiopods (*Productus*). At its base among the loose fragments were found the pygidia of small trilobites. On the south side of this mountain the jointed structure of limestone is well shown, the cliff presenting a notched or serrated face.

Another bluff, on the north side of the mountain, lies directly across the Town Branch valley from Fayetteville. Here over 9 feet of Archimedes limestone is exposed, overlain by about 20 feet of shale, but the accumulations covering the lower portion of the bluff renders an exact measurement of the limestone impossible.

West of Baxter Mountain the Archimedes limestone again appears near the center of the north half of section 33, in Miller Mountain. Its characters here do not differ from those already noted. In the detached fragment which had worked down the slope many of the fossil *Archimedes* are found, although an examination of the solid layers in the bluff revealed only a small number. Nevertheless, the inference is, from those found in the bluff and from the position of the fragments containing the fossils, that the layers richest in this type of remains must be near the top. Some of the larger specimens measured 7 inches in length. The remains of both corals and crinoids also occur here, and the latter, in the form of disarticulated stems, are especially abundant.

At Brooks Mountain, in the northwest quarter of section 35, and extending into the northeast quarter of section 34, the limestone forms the lowest member of the bluff, which is of considerable height on the south side of the mountain, and

covers a greater range stratigraphically than in Baxter Mountain or in Miller Mountain.

From the southwest corner of the corporate limits of Fayetteville a series of low hills extend southwest along the west side of the St. Louis and San Francisco Railway, in all of which this limestone appears, though forming no bluffs of importance, unless an exception be made in the case of a low outcrop on the south side of Kelton's Hill, accompanied by a considerable accumulation of loose blocks and fragments. On the second and third hills this formation is almost entirely represented by fragments, and even these are not always abundant. The limestone outcrops in the northwest corner of the southwest quarter of section 29, at the house of Mr. W. F. Dowell. At one time it was burned at this place for lime. This is an isolated patch of small extent, rising above the Fayetteville shale, which forms the bed-rock of all the valley land in this and adjoining sections. Moreover, this limestone is evidently near the bottom of the formation, as indicated by a well which passed through a few feet of limestone before entering the underlying Marshall shale. The hills above mentioned and this isolated mass are in a direct line with the low spur, which juts to the northeast from the center of section 31, in which the Archimedes limestone again appears.

On the northeast slope of Kelton's Hill it became necessary to make an excavation for the bed of the railway, and here, too, the limestone was exposed, showing its characteristic fossils, *Productus*, *Archimedes* and crinoids. Lying in the same line, across the valley to the northeast, an outcrop appears along the line of the railway, and the rock is also shown in the bed of the spring branch adjacent to the railway on the east, from which it is readily traced into the cut north of the Fayetteville station. On the level of the railway the outcrop is, for the most part, covered, but beneath the reddish soil the limestone is encountered in the ditch draining the road-bed.

Near the center of section 16, in the bed of a small stream south of Evergreen Cemetery, the limestone dips quite rapidly to the east, and is overlain by bluish black shale. Forty feet above this it again appears in the southeast quarter of the northwest quarter of the same section. From this point it may be traced by an outcrop and large fragments weathering into shaly layers, in a northwest direction into the property of the Arkansas Industrial University, where it is lost under sandstone debris.

After an interval of half a mile the outcrop again appears near the crossing of the half section line and that between sections 8 and 17. The exposure here is of especial interest, the contact of the limestone and the underlying sandstone layers being clearly shown. Resting directly upon the Batesville sandstone is a thin, very hard, arenaceous layer passing into a brownish, shaly, very fossiliferous limestone having a thickness of from 10 to 15 feet, and containing crinoid stems in the greatest abundance, with occasional *Archimedes* and many other bryozoans. At a higher level on the hillside, hard, compact, gray limestone appears, parts of which weather into rounded, dome-shaped masses and the uppermost portion into flattish rounded fragments. In these the *Archimedes* are of a more robust character than those observed in the brownish layers. Owing to erosion the continuity of the section is incomplete, but indications lead to the belief that the limestone here has a thickness of from 25 to 30 feet.

From this point the limestone may be followed in a direction slightly east of north into the west half of the southeast quarter of section 8, where a considerable dip to the east or slightly south of east is met, reminding one of that found in the bed of the stream south of Evergreen Cemetery. The course of the outcrop is now directed to the east and not far from the east-west half-mile line, in the northwest quarter of the southeast quarter, it disappears from view. Limestone is again encountered in the bottom of a well near the point of

crossing of the Elm Springs road and the corporation line, and it is undoubtedly continued in the reddish-brown limestone which occurs near the base of University Hill, west of and above the railway cut, within the limits of Fayetteville. It is underlain by the Fayetteville shales, and must be regarded as the Archimedes limestone beginning to thin out toward the north.

A low bluff of this formation is found on the eastern side of Archias Mountain, near the center of section 17. It resembles those found elsewhere, with the usual accompaniment of fragments. On the north slope but little limestone appears, and on the west and south it is entirely concealed.

As has been mentioned, there is a large exposure of Fayetteville shale about the north end of Millsap's Mountain, in the west half of section 18, which continues up the mountain side for 60 feet or more, after which there follows an interval covered with loose fragments; but at the height of 160 feet above the valley fragments of a shaly, highly fossiliferous limestone are found, composed largely of crinoid stems, and of a reddish brown color, resembling that resting on the underlying sandstone in section 17, or where the limestone is thinning out, as it is undoubtedly here.

Archimedes limestone also appears on the south slope of Washington Mountain, fragments being found about 130 feet above the valley. While bluffs are not wanting in this mountain, they occur at a higher horizon in the Washington shale and sandstone. The limestone outcrop is here indicated by detached fragments. From the southwest portion of this mountain a very narrow ridge or "backbone" extends in a southwest direction, through the northwest quarter of section 30, connecting it with Kessler Mountain. For a part of the distance this ridge is capped, as is Washington Mountain, with sandstone, but it soon gives way as the ridge decreases in height, exposing the Archimedes limestone, which in turn, in the lowest part of the ridge, gives way to the Fayetteville shale.

Along the eastern slope of Kessler Mountain, the limestone passes through the western half of section 30 into section 31, where, as already described, it skirts the foot-hills.

At the southern extremity of Kessler Mountain, in fragments and outcrops, it covers a vertical space of from 50 to 60 feet. Reddish, very fossilferous fragments below are followed higher up by gray fragments; above these is an outcrop of hard, gray, massive rock. Fine specimens of *Archimedes* are found in this locality.

The character of this limestone on the east side of East Mountain, in the northwest quarter of section 14, resembles that of the fragments found on Millsap's and Washington Mountains, and the lower layers also of the exposure in the northern part of section 17, that is to say it is completely changed from its appearance in the bluffs on Baxter and Brooks Mountains to the south and southeast. It is shaly, of a brownish red tinge, especially where weathered, and is highly fossiliferous. Crinoid stems are abundant, while cyathophylloid corals and bryozoans likewise abound. The remains of a gasteropod also appear and the *Archimedes* are comparatively scarce and not so robust as those found in the gray limestone. Finally, the occurrence of pebbles in the rock shows that the limestone has become impure.

It is unfortunate that the exact thickness of the formation at this point could not be ascertained, as the base of the outcrop is covered. The indications, however, all point to a rapid thinning out. Above the limestone there are here exposed two feet or more of pebbly shale. The pebbles are of a larger size than those in the limestone and are arranged wi.h their longer axes parallel, as in a shore deposit. Impure limestone undoubtedly occurs in the foot-hills connecting East and Pierce Mountains, near the north line of section 14, and in one other locality near the northeast corner of that section the reddish layers appear in the bed of a stream.

In addition to the localities previously mentioned, the Archimedes limestone is met in 16 N., 29 W., near the summit of the elevated land lying between the Main Fork and the Middle Fork of White River, principally in section 34, but extending into the northwest quarter of the southwest quarter of section 35, and also skirting, in a sinuous course, the foothills of Round Mountain, in the eastern part of the township.

The occurrence of dark bluish pebbles in the upper layers of the limestone was also noticed by Mr. Harris, in the exposures in the various little ravines along the southern border of 17 N., 29 W. He observed, too, that this feature, together with the red color, gradually disappears in the southern extension of the limestone, the rock becoming lighter in color and of a semi-cherty appearance.

In two localities, viz., in Fox Mountain and in the southeast quarter of the southwest quarter of section 21, both in 17 N., 29 W., the limestone is apparently represented by a sandstone from which all calcareous matter, however much or little it may have been, has been dissolved.

The northernmost point at which the Archimedes limestone has actually been seen, is in 17 N., 29 W., the southeast quarter of the northeast quarter of section 16. Here it consists of a calcareous layer underlain and overlain by flaggy sandstone. It is rather the representative of the Archimedes limestone, and approaches a sandstone which, before weathering, was more or less calcareous. *Archimedes* are here abundant.

In the northeast part of the southwest quarter of the northwest quarter of section 28 this limestone appears in a wood road, having a strong northwest dip. Here it is no longer simply a calcareous layer, but a true limestone. The matrix is of a reddish color, in which there are imbedded numerous fragments of crinoids and *Archimedes*.

The southwestern part of the county.—The occurrence of the Archimedes limestone was also noted in the following localities in the southwest portion of the county :

At the residence of Mr. Robert Parks, in 15 N., 32 W., the southwest quarter of the southwest quarter of section 27, it appears about 235 feet above Prairie Grove. Its thickness here over twenty feet, and the characteristic fossils are abundant. Above the outcrop there is a sandstone, scattered fragments of which are found to the summit of the hill, 390 feet above Prairie Grove. The Boonsboro road crosses the limestone near the northwest corner of section 34, taking a higher level. From this point the road traverses a dark reddish, somewhat sandy soil, and again crosses the limestone in 14 N., 32 W., the northwest quarter of section 4, near the foot of Troutt Hill, three-eighths of a mile north of the Cane Hill mill. Going southward, the road enters the valley of Jordan Creek, on both sides of which high bluffs of the Archimedes limestone are conspicuous for more than a mile and a half. Boonsboro is situated in this contracted valley. In the exposure nearly south of the Cane Hill College building (west half of section 8), the limestone occurs twenty feet above the principal street of the town. The stone, which is hard, gray and very fossiliferous, presents a series of steps formed by the various layers. This exposure is from thirty-five to forty feet in thickness. North of Cane Hill College, in the road near the cemetery, there are shown, in its upper layers, many fossils in relief, but usually in a condition unfavorable for identification. The stems of crinoids, for example, are very prominent, with their disks piled one on the other like lozenges, forcibly reminding one of the appearance presented by the limestone slabs at the north end of the spur, in 16 N., 30 W., section 29. Descending here, compact layers of hard, gray limestone are met, the edges of which are rounded as if waterworn. At a lower level, these layers give way to fossiliferous limestone, showing again crinoid stems in relief. In one fragment a section of what appeared to be a gasteropod about an inch in diameter, was seen. There are also sections, apparently of brachiopods of good size, as well as many fragments

of *Pentremites*. The characteristic *Archimedes* is present and comparatively abundant. Again, near the base of the bluff, light colored limestone appears.

The entire thickness of the bluff at the Cane Hill mill is about 40 feet. A similar exposure appears at the base of the hill, east of the mill, across Jordan Creek. Here, as elsewhere noted, there is a luxuriant growth of grape vines, dogwood, and oak.

In 14 N., 32 W., the northwest quarter of section 5, on the township line just west of Bean's old mill, and a mile and a half northwest of Cane Hill College, there is another excellent exposure of this limestone, in which fossils are very numerous and the *Archimedes* very large. From the bottom of the bluff several fine springs gush, the waters of which were formerly used in running the abandoned mill. The base of the bluff is here 90 feet above the base of the exposure at Boonsboro, and limestone is encountered for 40 feet, above which appear the Washington sandstone and a portion of the Pentremital limestone.

The Archimedes limestone also appears in the south half of section 18, fragments being first seen 10 feet above the road from Boonsboro to Dutch Mills. Thirty feet above the road the fragments are more abundant, and the characteristic fossils plainly shown. Forty feet above the road the limestone gives way to sandy fragments.

Passing southeast through 14 N., 32 W., from New Town (Clyde Post-office), in section 17, to Morrow's school house, in section 36, fragments of Archimedes limestone occur at the spring near Milton Cox's house in the northeast quarter of section 20, derived no doubt from a higher level. In the northeast quarter of the northwest quarter of section 28, there is a high bluff back of James Brunk's house, in which this limestone is exposed for 20 feet. Above the limestone about 30 feet of sandstone appears, while below its exposure the talus covers at least 60 feet.

The ascent of the high crest of the Boston Mountains is begun near the northern boundary of the northwest quarter of section 27. About 30 feet above Fly Creek the road passes over the outcrop of the Archimedes limestone. Descending into the Cove Creek valley it occurs again in sections 35 and 36. At Morrow's spring, on the south line of the northwest quarter of section 36, all the prominent characteristics of this limestone are present.

There is an outcrop of the Archimedes limestone at Evansville, in the hillside near Littlejohn's mill, 80 feet above Evansville Creek, at the ford on the Evansville-Greersburg road. The highest exposure is 110 feet above the creek, showing the entire thickness to be not less than 30 feet. Between the Fayetteville shale and the limestone, there is a thin bed of the Batesville sandstone. Again, a quarter of a mile east of Evansville, in 13 N., 33 W., the west half of section 22, on the Evansville-Boonsboro road, the limestone is exposed with its usual appearance.

General conclusions.—The general conclusions regarding the Archimedes limestone are these: It is a characteristic formation, well marked and easily identified, hence, of great value as a guide in the location of positions stratigraphically over a large area in the county south of Fayetteville; it attains its maximum thickness at the base of the Boston Mountains, and especially in the outliers on the northern side; it thins out northward and undergoes a decided change lithologically about the latitude of Fayetteville, and finally, as stated by Mr Harris, degenerates into sandy layers and disappears, being recognized for the last time in 17 N., 29 W., section 16.

WEATHERING OF THE WASHINGTON SANDSTONE AND SHALE ON WASHINGTON MOUNTAIN.

CHAPTER IX.

THE WASHINGTON SHALE AND SANDSTONE.

Position.—The Washington shale and sandstone are named from Washington Mountain southwest of Fayetteville, in which these beds are exposed. The shale rests upon the Archimedes limestone. It is followed above by sandstone, or there may be a gradual passage from the shale, through flagging, into the sandstone layers. The distance between the Archimedes limestone below and the Pentremital above—that is, the interval occupied by the Washington shale and sandstone, varies somewhat, being greatest near the base of the Boston Mountains, and thinning out to the north. Near the town of West Fork it is 75 feet thick, while in Pierce Mountain, east of Fayetteville, a distance in a straight line of about eleven miles, it is 40 feet thick.

The proportion of this interval occupied by shale and sandstone respectively, in different localities, also varies considerably. In one of the bluffs adjacent to the railway near West Fork, 20 feet of shale rest directly on Archimedes limestone, and form a continuation of the bluff itself. Below the Robinson coal bank, southeast of that town, there are, below the Pentremital limestone, 25 feet of sandy, flaggy layers, followed below by 40 or 50 feet of gray shale. Farther north the proportion of sandstone increases. In Brooks Mountain, southeast of Fayetteville, there is a blending of the shaly and sandy layers, while in the bluff of Washington Mountain, southwest of Fayetteville, there is a yellow or brown sandstone (having some massive layers) above, followed by an arenaceous shale, made up of rather thick, lenticular layers below, the whole weathering so as to form numerous nests and caves. The pebbly shale before mentioned as resting upon the Archimedes

limestone, on the eastern flank of East Mountain, is followed above by a thick, yellowish brown, soft sandstone. The attention of the reader has already been called to the fact that where the Archimedes limestone thins out and this formation is present, as in the northeastern part of the county, it is merged with the Batesville sandstone.

Impressions of *Lepidodendron*, and of other plants of the Carboniferous period occur in these sandstones, in 15 N., 30 W., east half of section 7.

Exposures.—The following is a list of the more important exposures of the Washington shale and sandstone noted in Washington county. It is not to be inferred, however, that these are the only exposures of these rocks:

In 14 N., 30 W.
At Robinson's coal bank.
At the mouth of Mill Creek.
In 15 N., 29 W.: In the vicinity of Carter's Store, between Carter's and Durham.
In 14 N., 29 W.
In 14 N., 32 W.
In 15 N., 30 W., sections 2, 26 and 32.
In Bloyd's Mountain.
In 16 N., 30 W.: In Baxter Mountain, in Brooks' Mountain, in Fayetteville, in University Hill, in East Mountain, in Washington Mountain, in Archais Mountain and in McCullom's Mountain.
In 16 N., 29 W.: In the Round Mountain area, in the ridges between Main Fork, Middle Fork and West Fork.
In 17 N., 29 W.
On the north and the south sides of the main range of the Boston Mountains.

Local details.—In 14 N., 30 W., the descent from Robinson's coal bank in the southwest quarter of the southwest quarter of section 4, to the river, is quite precipitous over the outcrops of the Pentremital limestone, the Washington sandstone and shale, and the Archimedes limestone. In this locality the Pentremital limestone is apparently underlain for 20 or 25 feet by sandy, calcareous layers, somewhat flaggy in structure. An outcrop, with a perpendicular face of 5 feet, shows a series of layers, each of which had a thickness of from 4 to 6 inches. Among the beds is one of considerable hardness; beneath this flagging there is an interval of 50 feet, in which gray shale is

exposed, the shale occupying a position just above the Archimedes limestone. These beds lying between the Pentremital limestone above and the Archimedes limestone below are the Washington shale and sandstone.

Near the mouth of Mill Creek, in 14 N., 30 W., the northwest quarter of section 16, on the west bank of West Fork, beneath the Pentremital limestone, it is exposed as a thin-bedded, laminated sandstone.

The bluffs of Archimedes limestone in the vicinity of Carter's store, on Middle Fork, in 15 N., 29 W., are overlain and somewhat extended by the deposits of this formation, as, for example, on the left bank the Archimedes limestone is succeeded by 1 foot of conglomerate, 1½ feet of shaly conglomerate, followed by shale of about the same thickness, passing into flagging and sandstone, the combined thickness of which is 20 feet or more.

Ascending the Middle Fork from Carter's store sandstone is found both above and below the Archimedes limestone. At Mrs. Douglas', in 14 N., 29 W., section 14, a bluff, supposed to be of the Washington sandstone, rises 25 or 30 feet vertically from the water. As was expected, it is underlain by shale which appears at a lower level in the beds of several streams. Rocks of this formation are exposed also in the ridge between Middle Fork and Main Fork, as for example, on the road from Carter's store to Durham.

The occurrence of shale immediately above the Archimedes limestone is well shown in the bluff west of and above the railway, in 15 N., 30 W., the southeast quarter of the northwest quarter of section 32. Climbing up from the track one passes over a great quantity of loose, shaly fragments, which, upon further investigation, are found to have fallen from above the limestone bluff, which is here continued by a vertical wall of gray shale 20 feet thick. Upon the top of this bluff there are exposed thin layers of sandstone, having a thickness of 5 feet or more. And a similar arrangement of strata is observed in

all of the Archimedes limestone exposures west of the railway in this township.

Mr. Crozier estimates the thickness of this formation in a section of Bloyd's Mountain, the summit of which is in 14 N., 30 W., near the northwest corner of section 3, to be from 65 to 70 feet, of which the upper portion is massive and the lower portion shaly. Again, in 15 N., 30 W., the northern part of section 26, according to the same observer, it is a sandstone containing shaly layers but massive at the top, and in the southeast quarter of the southeast quarter, section 3, it is a shaly sandstone probably 50 feet thick. In the northeast quarter of section 2 the weathering of the softer shaly layers, which rest directly upon the Archimedes limestone, has left the hard sandstone in tabulated masses, supported on pedestals or forming overhanging shelves.

In the edge of a small hill in 15 N., 30 W., the east half of section 7, sandstone appears about 5 feet above the Archimedes limestone, the interval being either shale or shaly sandstone. In fragments of the sandstone were found the impressions of Lepidodendrons and other plants. Above the Archimedes limestone there are fragments of a coarse, sandy conglomerate.

Westward from the center of section 11 there are numerous sink-holes in the sandstone above the Archimedes limestone. As they were obstructed with brush and stones gathered from the fields, they could not be measured, but it is to be supposed that they continue to and into the Archimedes limestone, which occurs here at a depth of from 50 to 75 feet.

The north bluff of Baxter Mountain in 16 N., 30 W., the northeast quarter of the northeast quarter of section 28, shows on top of and in addition to the Archimedes limestone, 19 feet of shale, followed above by 9 feet of sandstone. This does not give the entire thickness of the Washington formation, inasmuch as the summit gradually slopes back from the bluff.

A similar sequence of rocks occurs in the bluff on the south side of Baxter Mountain. The estimated thickness of the Washington shale and sandstone is not quite as great as that on the north side, but above the sandstone there are a few fragments of limestone, the remains, evidently, of the Pentremital limestone, which must have formerly covered the summit.

On the south side of Brooks Mountain the Archimedes bluff is overlain by a gritty shale, with sandy layers, twenty feet thick, followed by seven feet of flaggy sandstone, above which there are three feet of thin shaly sandstone, all of which belong to the Washington beds.

Along the line of the railway in the southwest quarter of section 16, within the limits of Fayetteville, the shale overlying the Archimedes limestone has been exposed in obtaining material for the construction of the road-bed. At the bottom of the excavation, which is not far from the limestone, it is rather dark; higher up it weathers gray, and still higher it is a drab or yellow. This shale is succeeded by decomposing sandstone upon which rests a thin, sandy soil.

University Hill is capped with the sandstone member of this formation. It rests upon a rather light colored shale, locally known as "soapstone," which becomes dark beneath, especially near the point of contact with the limestone. The light colored shale has been frequently exposed in Dickson street between the railway and the campus of the University in the gullies made during heavy rains. The dip is here similar to that of the Archimedes limestone, namely, eastward.

An exposure on the east side of East Mountain in 16 N., 30 W., the northwest quarter of section 14, shows above the Archimedes limestone two feet of pebbly shale, followed by a thick-bedded, yellowish brown sandstone, eight or nine feet in thickness; the whole forms an overhanging ledge from beneath which the shale has been removed by disintegration and erosion. This formation, however, continues at least 20 feet higher.

Along the south side of the summit of Washington Mountain in the northeast quarter of section 30, these rocks form a bluff. The upper portion is of sandstone, yellow or brown, with some thick-bedded layers (five or six feet thick) and others but a foot or two in thickness. In places it weathers badly along the planes of lamination, forming "nests" and caves, furnishing a fine example of what may be termed a *nidular* sandstone. Beneath this sandstone, and above the Archimedes limestone, there is a hard shale made up of lenticular layers and decidedly arenaceous in character. It also weathers badly, leaving here and there nests and caves as well as shelf-like projections of the sandstone layers above. The entire thickness of the sandstone and shale is 40 feet.

The series of hills extending southwest from Fayetteville are all capped with the Washington shale and sandstone. The sandstone on the top of that in the west half of section 29 is ferruginous and hard above, with softer layers beneath. Erosion has removed the softer beds and left the harder layers projecting as a shelf. The total thickness of the bluff on the east side is from 15 to 20 feet. Forty feet below are fragments of the Archimedes limestone, supposed to be in place.

Archais Mountain in the west half of section 17 and the east half of section 18, in this township (16 N., 30 W.), is also capped with Washington sandstone, its geologic position having been determined by a ledge of Archimedes limestone appearing on the east side. On the north side of the mountain a thick bed of sandstone is exposed, of which large fragments, having been undermined, have fallen to a lower level.

In the east half of the southeast quarter of section 31, the following thicknesses were ascertained by leveling:

Shale, resting on the Archimedes limestone	22 feet.
Sandstone	$37\frac{1}{2}$ feet.

In this case the section is complete, and the entire distance between the Archimedes and the Pentremital limestone was measured, as it was also at Brooks Mountain; but in many

NESTS AND CAVES IN THE WASHINGTON SANDSTONE, NEAR THE SUMMIT OF WASHINGTON MOUNTAIN.

localities in 16 N., 30 W. it is the summit rock, as on Baxter and Miller Mountains, and in the series of low hills extending southwest from Fayetteville, Washington, Archais and Millsap's Mountains. On the south side of the last named mountain the thick bed of sandstone occurs in large, detached masses, which, at first sight through the undergrowth, present the appearance of a stone wall. The northward prolongation or spur of McCullom's Mountain is also capped with the Washington sandstone. On its eastern side, in the northeast quarter of section 32, the Archimedes limestone is overlain by from 25 to 30 feet of shale upon which rests 7 to 8 feet of sandstone, which forms a low bluff along the edge of the summit.

In 16 N., 29 W., the Washington shale and sandstone are conspicuous in the Round Mountain region, occurring in the southwest quarter of section 12, the south half of section 11, the southeast (diagonal) half of section 10, and the southeast corner of section 9, the north half of the north half of section 16, the north half of section 15, the north half of the northwest quarter, the south half of the southwest quarter, and the east half of section 14, the northwest quarter of the northwest quarter of section 13, and the greater part of section 23, besides a small area in section 24 and the north half of the northeast quarter of section 22. East of Round Mountain it appears in the east half of the east half of section 24. In the southern part of the township it occurs in the ridges between Main Fork, Middle Fork and West Fork, and in the northeastern part in section 7. Its occurrence in township 16 N., 29 W. is shown on the map of that township prepared by Mr. Harris and incorporated in the map of Washington county which accompanies this report.

In the southern part of 17 N., 29 W. a thin deposit of decayed Washington shale or "soapstone" is of frequent occurrence, resting upon the Archimedes limestone, but in many instances the top and bottom of the outcrop are so

covered that it is impossible to say what does lie in immediate contact with it.

Where the Archimedes limestone thins out and disappears the Washington formation is blended with the Batesville sandstone, as in the region west of the White River at Johnson's bend.

The Washington shale and sandstone appear both on the north and the south sides of the main range of the Boston Mountains. The top of the Archimedes limestone bluff at the foot of the range in 14 N., 32 W., the northwest quarter of section 28 (Mr. Brunk's place), is of this sandstone. In ascending the mountain in the northern part of section 27, there are at the base indications of sandstone along the road for 90 feet above the Archimedes limestone. On the south side of the range, at Morrow's in section 36, there rests upon that limestone 15 feet of brown shale, having some black layers near the top, followed by 30 feet of yellowish sandstone. From this point to the Pentremital limestone there is an interval of 50 feet strewn with sandstone fragments.

CHAPTER X.

THE PENTREMITAL LIMESTONE.

General characters—Beginning at the base of the series of rocks exposed in Washington county the Pentremital limestone is the third limestone from the bottom. It follows quite closely the distribution of the Archimedes limestone, but occurring at a slightly higher level it has suffered more by erosion, and its areal extent is therefore somewhat less. Its exposures are usually in bluffs, and for this reason it also has a pronounced effect upon the topographic relief of the county. In most localities it is divided into an upper and a lower member by the interpolation of sandstone and shale. The relative thickness of each of the components will be shown in the descriptions which follow, as well as in the columnar sections and in the chapter especially devoted to them.

In general appearance the Pentremital limestone, though of a somewhat darker color, closely resembles the Archimedes limestone. In most instances it is very fossiliferous, abounding in fragments of crinoid stems, many of them very large, brachiopods, corals, and is especially characterized by the presence of the remains of *Pentremites*. It is well developed in East Mountain, where the hard, gray, calcareous layers are divided into an upper and a lower section by the interpolation of a sandstone bed, a feature noticed also in other localities. This limestone, likewise, enters into the bench and bluff topography. It is, however, of especial interest, inasmuch as it immediately underlies the coal-bearing shale of this part of the State. With the included sandstone, it has a thickness in East Mountain of about 80 feet; in Pierce Mountain it is somewhat thinner; at the mouth of Mill Creek, south of the village of West Fork, its thickness is estimated at 90 feet, and south of the Boston Mountains and at the old Morrow coal bank it

is 70 feet thick. In general it has its maximum thickness in the outliers of the Boston Mountains south of Fayetteville, and becomes thinner to the north, disappearing in township 17 N., 29 W.

Occurrences.—The Pentremital limestone is exposed at a great many places in Washington county, among which are the following:

- In East Mountain near Fayetteville.
- In and north of Fayetteville.
- In McCullom's, Brooks and Pierce Mountains.
- In 16 N., 30 W., section 1.
- In 15 N., 30 W., in Parrick's Ridge, White Oak and Round Mountains, and at the base of Washburn Mountain in section 19.
- In 14 N., 30 W., at Robinson's coal bank, and at the mouth of Mill Creek.
- In 14 N., 29 W., at Brentwood.
- At the mouth of Snake Branch.
- In 17 N., 29 W., sections 30, 31, 20 and 21.
- In 16 N., 29 W., about the summit of Round Mountain, in the Ridge between West Fork and Middle Fork, and in section 7.
- In 15 N., 29 W.; in 14 N., 29 W., section 24.
- In 16 N., 31 W., in Kessler Mountain.
- At Mr. Sloan's in 14 N., 31 W., section 7, and elsewhere in the same township.
- In 14 N., 32 W., at Mr. Gifford's in section 3, and in the Boston Mountains, in sections 27, 36 and 25.
- In the vicinity of Evansville, in 13 N., 32 W.

Local details.—In East Mountain the Pentremital limestone outcrops in numerous localities, and especially at the northern and southern extremities of the mountain. Within the city limits of Fayetteville there are exposures at Cato's Spring (Big Spring), and in the bed of the neighboring stream, where it is overlain by sandstone, the higher limestone layers occurring on the top of the bench above. Upon this bench, on the south side of the mountain, near the Confederate Cemetery, there are great masses of limestone on the surface, and farther east it appears in place. A bench on the southeast side of the mountain in the southeast quarter of section 15, extending into the southwest quarter of section 14, is capped with the interpolated sandstone.

In front of the Fayetteville public school building (northeast quarter of section 16) there is a small outcrop of this

limestone, very hard and of a gray color. Large masses may also be seen near the Henderson school-house (colored) in the northeast quarter of the northwest quarter of section 15. North of Fayetteville it occurs in several places in section 10, as in the south half of the southwest quarter, and near the center of the section in the bed of a small stream, while at the large spring in the northwest quarter of the section there is an outcrop of this formation. Owing to a fault or breaking of the rocks through this quarter of the section, the continuity of the strata with those further east is broken. The limestone, 20 feet in thickness, rests upon two feet of sandstone, which in turn rests upon gray shale, the upper part of which is interstratified with sandy, flaggy layers, the thickest not being over six inches. This shale is evidently continuous with the Fayetteville shale, which leads to the conclusion that the Archimedes limestone has thinned out, and that the gray shale and sandy layers may possibly represent the Washington formation.

In 16 N., 30 W. the Pentremital limestone occurs in McCullom's, Brooks and Pierce Mountains. In the first named, it is found in the southwest quarter of section 32, extending south of the township line into 15 N., 30 W., the northwest of section 5. Its position is about 38 feet above the Archimedes limestone. The precise thickness of this limestone was not here ascertained, but it is probably not less than 60 or 70 feet.

On the summit of Brooks Mountain, 345 feet above the West Fork of White River, there occurs a limestone, which is undoubtedly the Pentremital. It is arenaceous and shows a decided tendency to break up into thin layers. It is highly fossiliferous, and the sandy grains are sufficiently numerous to affect its color, giving it a rusty tinge. Five feet below, on the south side of the mountain, a harder, less fossiliferous layer appears in the bluff, and 15 feet below the summit, the limestone passes into or is underlain by an interpolated bed of sandstone of great hardness, which upon being struck emits

a strong odor. Its thickness is estimated at 8 feet. At its base it is calcareous, and numerous fossils are exposed in a fragmental condition on the weathered edges, among which were noticed the heads of several species of *Pentremites.* Below, the limestone becomes massive, and at the height of 310 feet above the river, shale appears (probably a thin layer) followed by the flaggy, sandy layers of the Washington formation.

On the south side of Pierce Mountain, in the southeast corner of section 11, or in the southwest corner of section 12, there is shown at least 60 feet of the Pentremital formation, as follows:

Limestone, the lower member	25 feet.
Sandstone	20 feet.
Limestone, upper member	10 to 20 feet.

This probably does not represent the entire thickness.

In 16 N., 30 W., the northeast corner of the southwest quarter of section 1, a spring issues, apparently at the contact of an overlying sandstone with an underlying limestone, the latter being, in all probability, the lower portion of the Pentremital formation. There is limestone also near the township line on the eastern side of this section.

From 15 N., 30 W., the center of section 33, the outcrops of the Pentremital limestone pass eastward through the south half of section 34 to near the center of the southwest quarter of section 35, thence northward through the western tier of forties in section 26. At the northwest corner of the northeast quarter of the northwest quarter of this section the line of outcrops bears to the southeast as far as the southeast corner of the northeast quarter of the southeast quarter of the same section. It skirts the high land of sections 25 and 24, separating the ridges of these sections by an indentation over half a mile in length, and passing through the eastern half of section 23, it skirts the western slope of Parrick's Ridge. Bearing westward, it passes through the south half of section 14, then

northward through the east half of section 15, and eastward through the south half of section 11, inclosing White Oak Mountain, and after skirting the northern and eastern slopes of Parrick's Ridge, passes into 15 N., 29 W. Round Mountain (not to be confounded with the mountain of the same name in 16 N., 29 W.), the summit of which lies near the center of the northeast quarter of section 27, is likewise flanked by the Pentremital limestone. Mr. Crozier estimates the upper layers of limestone to be about 55 feet thick. In the sandstone underlying them, 40 or 50 feet below, he observed from 10 to 15 feet of limestone, all of which was above the Washington shale and sandstone.

Fifty feet above the Archimedes limestone in 15 N., 30 W., the northwest quarter of the southeast quarter of section 19, is a limestone which, from its position, is undoubtedly the Pentremital. A limestone outcrop, probably of the same horizon, runs nearly north through the west half of the northeast quarter of this section, near the base of Washburn Mountain. Passing down a gulch leading from Robinson's coal bank, in 14 N., 30 W., in the southwest quarter of the northwest quarter of section 4, to the West Fork of the White River, the Pentremital limestone occurs at 280 feet above the water at the ford on the Fayetteville-West Fork road and continues downward to the 185th foot level, thus showing the Pentremital limestone to have a thickness of 95 feet at this place. The harder layers appear at the top, that is, about 20 feet below the coal exposure. Beneath these the limestone grows somewhat shaly, and is apparently very easily disintegrated. Where it has scaled off and is exposed to the weather, it is impure and of a reddish tinge. A layer about 15 feet from the bottom was found to be very rich in brachiopod remains. Directly beneath the limestone there are a few feet of flagging, sandstone and calcareous layers, which soon give way to gray shale.

The Pentremital limestone is well exposed in the bed of West Fork at the mouth of Mill Creek, half a mile north of Woolsey's, on the St. Louis and San Francisco Railway, in 14 N., 30 W., the northwest quarter of section 16. The top of the outcrop is 90 feet above the water. For a large part of the distance between section 4 and the mouth of Mill Creek it forms a bluff. In the loose fragments which have fallen from it are found many of the characteristic fossils. Some of the crinoid stems are of large size, measuring five-eighths of an inch in diameter, with a thickness of that of a silver dime. North of Mill Creek, beyond Mr. H. W. Gilbraith's house, the bluff is lower, about 40 feet of limestone being exposed. Traced northward the outcrop occupies a continually higher position in the hills skirting the valley of the West Fork. From the mouth of Mill Creek the Pentremital limestone can be easily traced along the West Fork of the White River to Brentwood station, appearing at numerous points along the banks of that stream as well as along the line of railway which closely follows it.

In 14 N., 30 W., the northwest quarter of the southwest quarter of section 24, 15 feet of limestone, more or less covered, lies adjacent to the wagon road. At the mouth of Sharp's Branch, a short distance to the east, hard gray limestone appears in the road, and in the loose fragments, there are crinoid stems in the usual abundance, as well as corals, all of which are best shown upon weathered surfaces. On the east side of Sharp's Branch and less than a mile from Brentwood, a few feet of gray shale are exposed by the roadside, directly above the limestone, which appears in the road at frequent intervals as far as Brentwood. Near Brentwood station the contact of the limestone and the overlying Coal-bearing shale is shown. They seem to be separated here by a sandy layer about four inches thick.

There is a typical exposure of the Pentremital limestone in 17 N., 29 W., the southeast quarter of the northeast quarter of

section 30, and limestone undoubtedly of this formation appears in the northwest quarter of section 31. It is well represented in the southeast quarter of the northeast quarter of section 20; while in the northeast quarter of the southwest quarter of section 21 sandy and calcareous layers alternate, as is shown in the bed of a small stream flowing in a southern direction. In the southwest quarter of the southwest quarter of the same section Pentremital limestone was struck in a well at a depth of 12 feet. It appears again in a very sandy, impure form in section 29.

The most northern outcrop of this formation was found in 17 N., 29 W., southwest quarter of the southwest quarter of section 10, of this township. Great care was taken to look for the limestone in section 33 and in the east half of 32, but without success. It is very doubtful if it exists there at all, its position being evidently occupied by a very soft greenish red sandstone. A well dug in this sandstone in the southwest part of the southeast quarter of section 29 passed through nothing else. Other wells along the Fayetteville-Goshen road east of Son's chapel show the same formation. It is probable that in these localities some of the upper layers, at least of the soft sandstones, represent the Coal-bearing shale which overlies the Pentremital limestone.

In 16 N., 29 W. the Pentremital limestone occurs in Round Mountain, in section 14, in section 7, and in the ridge between West Fork and Middle Fork, in sections 29, 30, 31 and 32. According to observations made by Mr. Harris, the limestone in this township, as a rule, has a considerable thickness. He found the lower layers usually quite impure, as in section 7, but in the northeast quarter of the southwest quarter of section 29 they are true limestones.

In 15 N., 29 W., the northeast quarter of the northwest quarter of section 18, there is an outcrop of limestone about 40 feet thick overlain by gray shale—probably the Pentremital limestone and the Coal-bearing shale above it.

A quarter of a mile below Arnett school-house, in 14 N., 29 W., section 24, in the banks of Middle Fork, a thin-bedded sandstone is exposed, which is so thinly laminated where the water flows over it as to be almost shaly. Immediately beneath it, in the bed and banks of the creek 5 or 6 feet of the Pentremital limestone are exposed. A fine example of the thinning out of a stratum is shown here; a bed of shale suddenly contracts and disappears, allowing the sandy flagging to rest directly on the limestone.

The Pentremital limestone is also shown in Kessler Mountain southwest of Fayetteville. In 16 N., 31 W., near the line between the southeast quarter of section 36, and section 1 of 15 N., 31 W., there are exposed, beginning at the bottom, 20 feet of grayish brown limestone, the lower layers being shaly and inclined to break up into thin pieces. Above the limestone there is an interval of 10 or 12 feet covered with sandstone fragments which indicate the presence of an interpolated sandstone. Above this there are 10 feet of gray limestone, usually hard and compact, showing light or even whitish spots, and occasionally having a tendency to become shaly. This would give an aggregate thickness of 40 feet at this point, but from an examination of other exposures on Kessler Mountain, the conclusion is reached that 60 feet would not be too small an estimate, and it is very probable that the thickness is even greater.

On the mountain side, across the gap south of the Kessler Mountain, and separated from the Archimedes limestone by a shale deposit containing thin layers of sandstone, there is an impure, arenaceous limestone which gives off sparks and an odor when struck with steel, a peculiarity noted in the limestone of Kessler Mountain just described.

On the road leading southwest from Billingsly (Moffit Post-office), there is a fine exposure of typical Pentremital limestone at Mr. G. W. Sloan's in 14 N., 31 W., the northeast quarter of the northeast quarter of section 17. The charac-

teristic fossils, the heads of *Pentremites* especially, occur here in abundance and in a good state of preservation. The exposure occurs near the top of the north bank of Sweetwater Creek, and is overlain by the Coal-bearing shale. The bluffs along the Illinois River in this vicinity, can be seen from the road. They are said to be of limestone and shale, probably Pentremital limestone below and the Coal-bearing shale above.

In the northwest quarter of section 20, limestone overlain by shale, and having a sharp dip to the east, occurs in the valley of the Illinois River, a small mountain stream at this place.

The road from Boonsboro to West Fork leaves the Prairie Grove road near the half-mile line in 14 N., 32 W., section 4. Here it passes over the Archimedes limestone and follows a general course south of east to Blair's Creek in the southeast quarter of section 2. Ascending the hill over the limestone outcrop just mentioned there is a greenish yellow sandstone not less than 20 feet in thickness, followed by a reddish brick-colored soil, filled with sandstone fragments. At a higher level yellowish brown sandstone fragments appear, and then, at the height of 100 feet above the Archimedes limestone, the road passes onto a bench, after which it continues to ascend to the northeast quarter of the southwest quarter of section 3. Here, near Mr. John Gifford's house, 160 feet above the Archimedes limestone, there is a deep chasm in the rocky walls of which is the key to the concealed beds just referred to. Here the Pentremital limestone appears with all its characteristics, overlain by 20 feet of sandstone. The upper layers of limestone are about 30 feet thick, passing into a mixture of limestone and sandstone below, followed still lower by layers of limestone which in turn are succeeded by soft sandstone. There is the same succession of strata in descending the hill to New Hope school-house near the line between sections 2 and 3, the outcropping limestone appearing in the road, beneath which is the soft yellow sandstone that occurs in the gulch. In the southern part of this township (14 N., 32 W.), Pentremital

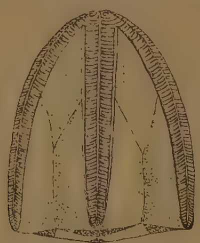
limestone appears on the road from Boonsboro to Morrow's school-house, in section 27, 140 feet above Fly Creek, or 90 feet above the Archimedes limestone. South of the road, in this section, 200 feet above Fly Creek, the limestone with 10 feet of sandstone, more or less calcareous, forms a bluff which is overlain by shale.

In passing up the bed of a small branch, from the house of T. A. Morrow, in the east half of the northwest quarter of section 36, to the old Morrow coal bank, this formation appears as follows:

Limestone	40 feet.
Shaley layers	20 feet.
Limestone	10 feet.
Total thickness of at least	70 feet.

Near the house of Mr. Earles King, in section 25, there is a bluff of this limestone. The exposure is 40 feet thick, and, as is shown in the bank of Cove Creek south of this house, is underlain by gray shale.

In the southwest corner of the county Pentremital limestone also occurs in the vicinity of Evansville. Here it is 75 or 80 feet above the Archimedes limestone, the Washington shale and sandstone separating the two limestones.



Head of Pentremites; enlarged two diameters.

CHAPTER XI.

THE COAL-BEARING SHALE.

Characters.—All the coal found in Washington county occurs in the Coal-bearing shale. The shale is enclosed between the Pentremital limestone below and the Kessler limestone above. In contrast with the Fayetteville and Eureka shales, it is, in some localities, as for example, at Lemon's coal pits, seven miles northeast of Fayetteville, very fossiliferous, affording numerous plant remains, a list of which is given below, and occasionally those of spiders. The shale is argillaceous, of a black, gray or bluish color and slacks readily upon exposure to the air. In thickness it varies from 90 feet in the East Mountain section to 60 feet on the south side of the Boston Mountains.

The included coal bed occurs from 15 to 20 feet above the Pentremital limestone and in the various prospect holes and pits shows a thickness varying from 6 to 14 inches. Although very thin (its maximum thickness is 14 inches) this coal bed is of some economic value. The shale is widely distributed, and from its position immediately above the Pentremital limestone is easily recognized.

Occurrences.—The Coal-bearing shale is exposed notably at the localities mentioned below:

In McCullom's Mountain, in East Mountain and in the hill north of Fayetteville. In 14 N., 29 W.; in 17 N., 29 W,. at Lemon's coal bank in section 20; in 16 N., 29 W. In 14 N., 32 W., it is exposed in the main ridge of the Boston Mountains, in section 27, and at the Morrow coal bank, in section 36. In 15 N., 30 W., it is exposed in White Oak and Round Mountains, in the flanks of Bloyd's Mountain and of Parrick's Ridge, and in the old coal pits in sections 24, 25, 26 and 35, and on Washburn Mountain; in 13 N., 33 W.; in 14 N., 30 W., at the

old Male coal bank (Privett's coal bank), at Brown's or Robinson's coal bank, and at Brentwood. In 15 N., 29 W., it occurs in section 7.

Local details.—In Washington county the Pentremital limestone is overlain by the Coal-bearing shale, a black or grayish and bluish shale containing coal. The geologic horizon of this coal is considerably lower than that of the coal mined in the Arkansas Valley. The latter coal overlies the Millstone Grit formation which occurs in the summit of the Boston Mountains, while the former underlies it at a considerable depth.

This shale appears on McCullom's Mountain in 16 N., 30 W., the southwest quarter of section 32, and in 15 N., 30 W., the northwest quarter of section 5. A prospect hole dug near the line between these sections revealed a bed of coal from 6 to 8 inches thick, occupying a position 15 or 20 feet below the summit, which is but a few acres in extent and covered with loose fragments of sandstone. The study of the position of coal here and of its relation to the underlying formations has been of great value in ascertaining its position at other places. On account of its height stratigraphically this shale is confined to about the same localities as the Pentremital limestone. It circumscribes East Mountain, and coal has been found at several places on its flanks, namely: at George Lindley's, within the limits of Fayetteville, in 16 N., 30 W., near the northeast corner of the northeast quarter of the northwest quarter of section 15; at the Jackson bank, in section 10, on the west side and in the southwest quarter of the southwest quarter of section 11 on the east. At the Jackson bank only has any attempt been made at mining. The bed at this place has a thickness of from 9 to 11 inches.

In a cove of East Mountain, in the northwest quarter of the northeast quarter of section 15, 50 yards east of the Fayetteville corporation line, the Coal-bearing shale is exposed in the bed of a small stream to 30 feet above the level of the

Pentremital limestone, and although the coal is not visible, the outcrop is in about the position in which it may be expected to occur.

The Coal-bearing shale with thin calcareous layers occurs along the Fayetteville-Springdale road near the center of section 10, and the road itself passes directly over the outcropping coal.

Extending westward the Coal-bearing shale is conspicuous on the southeastern slope of the hill west of East Mountain and north of Fayetteville. Prospecting shows the enclosed coal bed to be about 9 inches thick—not sufficient to warrant working.

An experimental shaft sunk in the west half of the northeast quarter of the southwest quarter of section 10 is said to have passed through the following:

Black shale	8 feet.
Coal	9 incnes.
Shale	12 feet 3 inches.
Limestone (Pentremital)	10 feet 10 inches.
Total	31 feet 10 inches.

Near the top of the adjacent hill the shale is grayish and the hill itself is capped with sandstone.

In the northeast corner of this township (16 N., 30 W.) this shale rests upon the Pentremital limestone as is shown in well excavations. In 17 N., 29 W., it is found in sections 20 and 21, extending from the northeast quarter of the first named section in a northeast direction. Lemon's coal bank in the northeast quarter of section 20, is the best developed and most profitable one in Washington county.

The coal bed, which has a thickness of about 13 inches, occurs in bluish gray shales not more than fifteen feet above the Pentremital limestone. The amount of shale above it, however, varies greatly. On the hill just east of Lemon's bank, there seems to be but little, while in some of Lemon's pits there is from 30 to 35 feet.

The following is a list of plants found in the shale in this locality:

LIST OF FOSSIL PLANTS FOUND AT LEMON'S COAL BANK.

BY GILBERT D. HARRIS.

Vascular Cryptogams or Acrogens.

Class—EQUISETACEÆ.

Order—Calamariæ.

Bornia radiata (Brgt.), Schp., common.

Sphenophyllum bifurcatum, Lx , not common.

Sphenophyllum saxifragæfolium, Germ., Lx., common.

Class—FILICACEÆ.

Order—Neuropterids.

Neuropteris smithsii, Lx., common.

Order—Alethopterids.

Alethopteris helenæ, Lx., very common.

Order—Sphenopterids.

Sphenopteris.

S. " *inequilateralis*, Lx., common.

S. " *crenata*, Ll. & Hutt, common.

S. " *hœninghausii* (?), Brgt., rare.

S. " *obovata*, Ll. & Hutt., common.

Eremopteris cheathami, Lx., rare.

Class—LYCOPODIACEÆ.

Lepidodendron rushvillense, Andrews, rare.

Lepidodendron modulatum (?), Lx., rare.

Order?—Noeggerathieæ.

Whittleseya microphylla, Lx., very common.

Whittleseya elegans, Newby. or a n. s., rare.

FRUIT SPIKES.

Class—EQUISETACEÆ.

Order—Calamariæ.

Calamostachys lanceolata, Lx., common.

Macrostachya, sp., common.

Class—LYCOPODIACEÆ.

Lepidocystis quadrangularis, Lx., common.

NUT-LIKE FRUITS.

Class—CORDAITEÆ.

Cardiocarpus bicuspidatus, Sternb., common.

Carpolithes transsectus, Lx., very common.

The shaft now worked at Galliger's bank, near Lemon's, a once famous locality, has not produced as many or as fine specimens as formerly. Mr. Harris, however, succeeded in finding the following at that locality:

Class—EQUISETACEÆ.

Order— Calamariæ.

(?) *Asterophyllites gracilis*, Lx., and fruit.

Calamostachys lanceolata, Lx.

Class—FILICACEÆ.

Order—Neuropterids.

Neuropteris smithsii, Lx.

Order—Alethopterids.

Alethopteris helenæ, Lx.

Class—LYCOPODIACEÆ.

Order—Sagillariæ.

Sigillaria brardii, Brgt.

Class—CORDAITEÆ.

Trigonocarpus schultzianus (?), Geop. & Berg.

Trigonocarpus olivæformis (?), Ll. & Hutt.

In 16 N., 29 W., the Coal-bearing shale or its representative, occurs in but two localities, viz.: In section 36, near the summit of the ridge between Main Fork and Middle Fork, and in section 14 near the summit of Round Mountain. In the former locality there are, according to the observations of Mr. Harris, probably 75 feet of sandy shale. In the latter, according to the same authority, sandstone has the Pentremital limestone below and shale above it.

In 15 N., 30 W., this shale occurs high up on the flanks of the elevated region in the east half of the township. It ap-

pears near the summit of White Oak and Round Mountains, and extends from the flanks of Bloyd's Mountain, in sections 33 and 34, around the high area in sections 35, 26 and 25. It can be traced around Parrick's Ridge; that is, through section 22, the east half of section 23, section 13, and the south half of section 12. Near the northwest corner of the northeast quarter of the southeast quarter of section 24, there is an old coal-pit. The bed could not be seen, but it is said to have a thickness of 10 inches. The shale in this locality is quite thick and of several colors—black, blue and yellow.

The well at J. R. Malone's in 15 N., 30 W., the northeast corner of the northwest quarter of the southwest quarter of the same section, passes through sandy red shale into black shale. Coal has also been dug near the center of the north half of section 25 (Malone coal bank). The bed is here of the usual thickness, from 10 to 12 inches. Above the coal there is a bluish shale. Mr. Crozier has also noted the occurrence of reddish and black shales above the Pentremital limestone on Round Mountain, in section 27. In the southwest quarter of the northwest of section 26, Mr. Crozier saw a pit in which a 5-inch bed of "rotten coal" was encountered. As it occurred far above the Pentremital limestone, he concludes that it must be a second bed. If so, this is its thickest development of the Coal-bearing shale in Washington county, and this second bed, instead of occurring beneath the bed ordinarily worked—a very popular theory with the searchers for coal—is really above. Explorations for coal have likewise been made in the blue shale near the center of section 26.

According to the same observer, blue shale is exposed in the northeast quarter of the northwest quarter of section 35. Here a coal pit has been opened in which there is a bed of coal 9 inches thick.

In the western part of this township (15 N., 30 W.), the shale occurs in the flanks of the Washburn Mountain, having

been met in excavating a well near the east line of the northwest quarter of section 19.

The old Male coal bank (now Privett's coal bank) is situated on the head waters of Mill Creek, a tributary of the West Fork of White River, in 14 N., 30 W., the northeast quarter of the northeast quarter of section 2. It has been worked more or less for many years. The coal bed, which outcrops in the bed of a small stream, is from 10 to 11 inches in thickness Where examined it was overlain by a limestone conglomerate 18 inches thick, containing dark gray and brownish pebbles of various sizes, which must be removed by blasting before the coal can be taken out. The shale rests upon this rock. At no other point has this conglomerate been found, and, according to Mr. Male, it extends for a short distance only upon the coal.

Robinson's coal bank (formerly Brown's) is situated in 14 N., 30 W., in the southwest quarter of the northwest quarter of section 4. It was first opened about forty years ago. The coal is 11 inches thick, and lies 20 feet above the Pentremital limestone. Above and below the coal bed is gray shale, in which, 10 feet above the main bed, there is a thin carbonaceous layer underlain with fire-clay.

In the section of Bloyd's Mountain the interval between the Pentremital limestone and the Kessler limestone is 150 feet. This is wholly occupied by the Coal-bearing shale. A section of the mountain south of Mill Creek, shows the same distance between the limestones. The Pentremital limestone which occurs along the east bank of West Fork, is overlain by a shale in which, ten feet higher up, there is exposed one and a half feet of thinly laminated sandstone. From this point to the Kessler limestone above the outcrop is concealed, but the nature of the slope leads to the belief that the underlying rock is shale or shaly sandstone, that is, the Coal-bearing shale.

Just northwest of Brentwood station, about the line between 15 N., 29 W., and 15 N., 30 W., the contact of the Pentre-

mital limestone with the overlying Coal-bearing shale is shown along the line of the railway. There is here a thin layer of sandstone, perhaps 4 inches thick, between the limestone and the shale. Above this exposure there is a bench, on the slope of which there are scattered fragments of sandstone, and wherever the shale appears it is rather flaggy in character. Two hundred yards southeast of the railway station, in a cutting for the road-bed, is an impure limestone, beneath which there is sandstone passing into shale beneath. This rests upon the Pentremital limestone, which is exposed in the bank of West Fork, 30 feet below.

Coal has been discovered in 15 N., 29 W., the southwest quarter of the northwest quarter of section 7. The outcrop is reported to be 11 inches thick. Farther south grayish shale also occurs in the northwest quarter of section 18, on a knoll above the Pentremital limestone.

Mention has already been made of the Pentremital limestone at Mr. Sloan's in 14 N., 31 W., section 17. This outcrop is overlain by the Coal-bearing shale, which is, in some places, of a light gray or yellow color. From this point it appears at intervals along the road as far as Howell's graveyard, in section 9.

On the main ridge of the Boston Mountains in 14 N., 32 W., section 27, gray shale is exposed above the Pentremital limestone, but the surface is so covered with sandstone fragments that the thickness can only be approximated—say from 65 to 75 feet. Coal is reported on Mr. Reinhart's land, in the southeast quarter of this section.

The Morrow coal bank, in 14 N., 32 W., the north half of section 36, lies on the south side of the main ridge, on the head waters of Cove Creek. The coal bed, which is not now exposed, is said to be 14 inches thick, and occupies a position about 20 feet above the Pentremital limestone, resting on shale of a greenish brown color. Above it are probably 40 feet of

shale, making the entire thickness 60 feet or more. Then follows the thin-bedded Kessler limestone above.

In ascending the mountain southeast of Evansville, in 13 N., 33 W., section 27, a gray shale is encountered resting upon a limestone supposed to be the Pentremital.

A PARTIAL LIST OF THE COAL OPENINGS AND OUTCROPS IN WASHINGTON COUNTY.

1. Lemon's bank, 17 N., 29 W., northeast of section 20.
2. Crawford's bank, near Lemon's.
3. Old Shepherd bank, south of Lemon's.
4. Other openings in the vicinity of Lemon's.
5. Jackson's bank, 16 N., 30 W., southeast of northeast of section 10.
6. ...., 16 N., 30 W., near the center of section 10.
7. ...., 16 N., 30 W., northeast of southwest of section 10.
8. ...., 16 N., 30 W., southwest of southwest of section 11.
9. George Lindley's, 16 N., 30 W., northeast of the northwest quarter of section 15.
10. Near Fayetteville station, 16 N., 30 W., northeast of the northwest quarter of section 16.
11. ...., 15 N., 29 W., southwest of the northwest quarter of section 7.
12. Malone's bank, 15 N., 30 W., north half of section 25.
13. ...., 15 N., 30 W., northeast of the southeast quarter of section 24.
14. ...., 15 N., 30 W., southwest of the northwest quarter of section 26.
15. ...., 15 N., 30 W., northeast of the northwest quarter of section 35.
16. Male's bank, 14 N., 30 W., northeast of the northeast quarter of section 2.
17. Robinson's bank, 14 N., 30 W., southwest of the northwest quarter of section 4.

18. Turner's bank, 14 N., 31 W., northeast of the northwest quarter of section 21.

19. ...., 14 N., 32 W., southeast quarter of section 27.

20. Morrow's bank, 14 N., 32 W., north half of section 36.

Beside these openings and natural exposures it will be seen from a study of the geological map, that the horizon of the coal bed is pretty constant, and that while the coal has a tendency to be pockety and irregular in thickness, the bed in all probability connects the outcrops mentioned above or located on the map.

The statistics of production by the coal mines of the county is given in the chapter upon economic geology.

CHAPTER XII.

THE KESSLER LIMESTONE.

Character and position.—The next bed above the coal-bearing shale in Washington county is the Kessler limestone. This is the uppermost of the Lower Carboniferous series and of the calcareous beds, being followed above by the shales, sandstones and grits of the Coal Measures. It is named from its occurrence in Kessler Mountain, southwest of Fayetteville. Unlike the Archimedes and Pentremital limestones, the Kessler limestone does not occur in thick masses, but in thin layers.

In working out the stratigraphic geology of Washington county above the Coal-bearing shale the difficulties of the geologist are materially increased, for he has reached an elevation where the ravines and hollows are less precipitous and consequently the outcropping of strata is of less frequent occurrence. And so it happens that a thin stratum, such as that of the Kessler limestone, is perhaps more often covered than exposed.

In several localities it appears as a thin-bedded limestone having a thickness of from 10 to 12 or more feet above the Coal-bearing shale. It is found near the summit of East Mountain, having a number of outcrops on the west and southwest sides, but on the east and south it is usually covered, although fragments sometimes occur as near as the northwest corner of the southeast quarter of the southwest quarter of section 11, 16 N., 30 W., 75 to 80 feet above the Pentremital limestone. Wherever exposed it is shaly, varying somewhat in color from gray to reddish brown, with occasional light streaks.

Exposures.—It is exposed at the following localities :

In East Mountain and in Kessler Mountain.
In 14 N., 30 W., in Bloyd's Mountain, at Brentwood, and in the mountain northeast of Woolsey's.
In 16 N., 29 W., section 32.
In the main range of the Boston Mountains and at the old Morrow coal bank, and near Evansville.
In 15 N., 30 W., in White Oak and Round Mountains.

Local details.—The Kessler limestone appears high up on the slope of Kessler Mountain, in 16 N., 30 W. Here it is from 10 to 15 feet thick, thin bedded, yellowish in color, becoming reddish-brown near the top where its shaly and sandy upper layers pass into sandstone. The only other locality in this township in which it could be expected to appear owing to its high stratigraphical position, is in Pierce Mountain, and here no well defined outcrop has been seen.

In 16 N., 29 W., in section 32, Mr. Harris recognized this limestone near the summit of the mountain, where it has a thickness of 10 feet. In his examination of Round Mountain, in section 14, however, he failed to find it, as for some distance above the Coal-bearing shale there was no outcrop of rocks visible.

In 15 N., 30 W., Mr. Crozier reports the Kessler limestone on White Oak Mountain in section 14, and near the summit of Round Mountain in section 27. On the north side of the former, although he was unable to find a good exposure, from the height of the bench he estimates its thickness at from 10 to 15 feet. It is so friable and soft that it has crumbled away and disintegrated very much. Large masses have apparently broken off and slid down upon the sandstone and shale below, where they have gradually decomposed, giving the slope a much broken surface; on some of the heaps found here the limestone is still seen. On the opposite side of the ridge he reports a better exposure 75 feet below the sandstone and underlying the sandstones of the Millstone Grit formation.

West of the summit of Bloyd's Mountain, in 14 N., 30 W. (northeast quarter of the northwest quarter of section 4), and on the north slope, this limestone appears 380 feet above the village of West Fork. It presents its usual shaly characters and forms a low bluff, which at this point is more than 4 or 5 feet high. Its course is marked by the customary fringe of fragments upon which there is a remarkable growth of moss.

Northeast of Woolsey's, a station on the railway south of West Fork, Kessler limestone occurs on the mountain side 140

feet above the Pentremital limestone exposure at the mouth of Mill Creek, a distance closely corresponding with that noted in the Bloyd Mountain exposure. The outcrop is here 3 feet thick and well marked, fragments being scattered from 25 to 30 feet below it. The weathering of some of the detached masses is, in occasional instances, peculiar; one surface presenting the appearance of a weathered conglomerate.

Scarcely a quarter of a mile south of Brentwood station the Coal-bearing shale overlying the Pentremital limestone disappears beneath the bed of the railway, and there is presented a face of rock 20 feet high. It consists of impure limestone and of shaly and sandy layers. Not far from this exposure the road turns to the south, and on the east side there is about 12 feet of impure limestone, 5 feet of shaly or flaggy layers and 4 feet of limestone. This is supposed to be the Kessler limestone.

That it exists in the main ridge of the Boston Mountains is confirmed by the section made at the old Morrow coal bank, in 14 N., 32 W., section 36. Here there is as much as 40 feet of shale above the coal, above which 10 feet of limestone are exposed. Its character and position indicate that it is the Kessler limestone.

Again, ascending the mountain southeast of Evansville, several limestones are passed over successively: the Archimedes near the base at Littlejohn's mill; then at a higher level, fragments of the Pentremital are encountered, and higher still fragments of a third which must be the Kessler limestone.

CHAPTER XIII.

THE MILLSTONE GRIT FORMATION.

Position and character—The highest rocks exposed in Washington county belong to the Millstone Grit formation at the base of the Barren Coal Measures. They overlie the Kessler limestone described in the last chapter, and underlie the rocks of the Productive Coal Measures which occur in the Arkansas Valley. No attempt is made in this report to distinguish between the various shales and sandstones of this formation. The great similarity of the different beds renders it well nigh impossible to separate them one from another; moreover, it has not been possible in the time allowed for the work to trace out and locate them through the thinly settled region of the Boston Mountains where they are most abundant.

In general, these sandstones and shales cap the Boston Mountains and their outliers, and wind in and out along the sides of the ravines and spurs that extend northward from the main ridge. The outcrops of the shales are generally concealed by debris and residuary soils, while the more massive sandstones and grits often form conspicuous bluffs on or near the mountain tops.

Exposures.—The following are some of the localities at which the rocks of this series are exposed:

On East Mountain and Kessler Mountain; near the summit of White Oak Mountain; on the summit of Round Mountain in 15 N., 30 W., section 27; on Bloyd's Mountain in 14 N., 30 W.

Near Lemon's coal bank in 17 N., 29 W., in section 29 of the same township; on the hill near the Fayetteville public school building; on Parrick's Ridge; in section 25, 15 N., 30 W.; along the railway between Brentwood and Winslow; in a bluff in 14 N., 29 W., section 30; above Morrow's coal bank in 14 N., 32 W., section 36; on the mountains southeast of Evansville, and on the road to Boonsboro via Antioch Church.

On the ridge between Cove Creek and Fall Creek at Cincinnati; on Strayhan Mountain in 16 N., 33 W., section 29, and on Bell Mountain in 15 N., 33 W.

Local details.—Resting on the Kessler limestone in East Mountain there are at least forty feet of dark shale, as is shown by a well excavated on the upper bench of that mountain near the Fayetteville corporation line. This shale also occurs above the upper limestone on Kessler Mountain, having sandy layers at its base. Its thickness is about 40 feet. In Pierce Mountain east of Fayetteville, the occurrence of shale beneath the grit and sandstone has been noted.

Mr. Crozier reports a shale above the Kessler limestone on White Oak Mountain, in 15 N., 30 W., the northwest quarter of the northwest quarter of section 14, and its occurrence elsewhere on this mountain can be safely predicted. He also found this shale resting upon the limestone in section 26. Again, in the northeast quarter of section 27, he found it on the top of Round Mountain. Its thickness here is from 45 to 50 feet, and on it there are scattered fragments of a sandstone which once covered the summit.

Farther south, the shale appears on the east side of Bloyd's Mountain, but in the Mountain south of Mill Creek no exposure has been seen. There is, however, above the Kessler limestone, a covered slope, which is usually interpreted as indicating underlying shale or thin sandstone layers.

There now follows a succession of sandstones and shales to the summit of the Boston Mountains. No attempt has been made to classify them.

In the East Mountain section at Fayetteville the shale is followed above by sandy, flaggy layers and then by sandstone. On the summit, and especially on the south extremity, there are scattered numerous fragments of a grit, consisting of a brownish matrix in which there are imbedded angular grains of quartz. This rock is also found on the summit of Kessler Mountain and on that of the ridge between West Fork and Middle Fork, in 16 N., 29 W., section 32. While this, then, must be regarded as its normal position, owing to the thinning out and

consequent elimination of some of the beds that underlie it, it occurs in other situations at a lower level.

Thus, in the vicinity of Lemon's coal bank, in 17 N., 29 W., flaggy layers seem to overlie the Coal-bearing shale. A quarter of a mile east of the principal line of shafts, the amount of shale above the coal is small, and the succeeding layers, instead of being calcareous, are soft and sandy, while about 25 feet above the coal the coarse sandstone appears. There is grit also in the southeast quarter of section 29 of the same township upon the sandy layers which occupy the position of the Pentremital limestone, while in the southwest quarter of section 33 it rests immediately upon the Kessler limestone, and has a thickness of 5 feet.

On the hill near the Fayetteville public school, there are fragments of grits, although the underlying strata of sandstone apparently rest on the Coal-bearing shales.

The grit and its associated rocks appear in several places in 15 N., 30 W. Mr. Crozier has reported the occurrence of grits on the summit of White Oak Mountain; in section 14; on the high points of Parrick's Ridge; in sections 13 and 24 respectively, and also in section 25, where it lies some distance below the summit of the high land in section 36. He says: "Crossing the ridge from the center of the southeast quarter of section 25 to the center of the southwest quarter, I found no less than three distinct sandstone benches or cliffs, which, with the one at the top of the mountain in section 36, make four. That next to the lowest shows better than any of the others the coarseness of the Millstone Grit." The lowest sandstone, just west of the center of the southwest quarter of section 25, has its topmost layers three or four feet thick; below they are softer; together they have a thickness of about 20 feet. According to his sections there are shales between these sandstones.

The same observer reports grits on the northern peak of Parrick's Ridge, in section 13, 50 or 60 feet above a ledge of

fine-grained sandstone. On the south side of the peak this sandstone is in the form of thin flagging which has been undermined in places, leaving the layers projecting 10 feet.

In making the ascent of Everett or Sugar Mountain from the mouth of Mill Creek, in 14 N., 30 W., section 16, fragments of sandstone are found at the base of a bench, 60 feet above the Kessler limestone. From the character of the slope there is in all probability a bed of shale between the Kessler limestone and the sandstone above. Twenty feet higher, a low (5 feet) bluff of sandstone is exposed. Its lower layers are thin-bedded and soft, while the upper layers are evidently easily eroded along the lines of their lamination. The top of the sandstone bench is 120 feet above the limestone. Forty feet above the outcrop mentioned, on the surface of a broad bench that is 160 feet above the Kessler limestone, there are fragments of grit, similar in appearance to that found on East Mountain. A hundred feet higher is a bed of shale; immediately below the summit of the mountain, and 420 feet above the limestone, there is a broken sandstone outcrop. Crossing the mountains from this point through sections 14 and 23, towards Brentwood, are several sandstone benches and shale slopes. One spur equals, if it does not exceed Everett Mountain in height. In places the descent to Brentwood is completely covered by fragments and slabs of sandstone.

As might be expected, shales and sandstones are exposed at frequent intervals along the railway from Brentwood to the summit of the Boston Mountains at Winslow and also along the descent of the mountain on the south side of the range.

In the rear of Mr. Jackson's house, in 14 N., 29 W., the northwest quarter of the southwest quarter of section 30, there is a heavy bluff of ferruginous sandstone. The base of the cliff is made up of shaly and flaggy sandstone 12 feet thick, above which there are 15 feet of thick-bedded sandrock. Among the large fragments which had fallen from this outcrop are some remarkably fine examples of concretionary

structure. South of Mr. Jackson's, near the township line, and at a lower level than the sandstone bluff, dark colored shale appears along the railway. Continuing along the track towards Winslow, the shale is succeeded by sandstone, which, two miles above Brentwood, is at the level of the bed of the railway. An eighth of a mile further south, shale again appears, overlain by a coarse greenish yellow sandstone, of which from 2 to 4 feet are exposed in cuttings. This is overlain by 10 feet of shale, followed above by an exposure of sandstone 8 feet thick. Ten feet above this is a flaggy sandstone and 20 feet above the last exposure 2 feet of sandstone, underlain by gray shale. Approaching Winslow, but north of the 374th mile-post, at a still higher level (20 feet above the preceding), light colored shale appears showing a slight dip to the south. South of the mile-post mentioned the shale is succeeded by sandy and flaggy layers. Above Winslow station, in the cut leading to the tunnel, is a stratum of sandstone 3 feet thick dipping northward at an angle of from 5° to 8°. It is overlain by shale and beneath it there are thin sandstone and flaggy layers and shale. Continuing towards the tunnel there is a similar stratum *having about the same thickness and overlain by shale (of which 20 or 30 feet are exposed, weathering grayish brown and with sandy layers on top) and underlain by thin-bedded, flaggy sandstone 8 feet thick. The sandstone stratum itself is of a mottled grayish purple color, as seen on a newly broken surface. At the mouth of the tunnel the black shale which occurs beneath the flaggy layers is well exposed and through it the tunnel has been excavated.

On the south side of the Boston Mountains, above the Kessler limestone which overlies the Coal-bearing shale at the old Morrow coal bank, in 14 N., 32 W., the north half of section 36, there is a mass of broken sandstone. At one point a nearly level surface is completely covered with sandstone slabs,

*The similarity of these sandstones lead to the belief that there is a fault at this point and that what appears at first sight to be two beds is in reality one, which, owing to displacement, appears a second time.

from 4 to 6 or more feet in length, and from 6 to 8 inches thick, their regular form giving them the appearance of building material just taken from the quarry.

Above the limestones southeast of Evansville, there are shale and sandstone deposits. On the road from that town to Boonsboro by way of Antioch Church, after ascending from the bed of Evansville Creek, there are sandstone fragments, sandstone outcrops and sandstone benches until 14 N., 32 W., section 27, is reached.

Sandstone is also the prevailing rock in the ridge between Cove Creek on the west and Fall Creek on the east, embracing the area adjacent to the line between 13 N., 31 W., and 13 N., 32 W. At Fall Creek school-house, in 13 N., 31 W., in section 5, the creek passes over a thin-bedded sandstone ledge, making a fall of 8 feet. Farther south, in 13 N., 32 W., section 36, thick-bedded sandstone occurs east of the road leading into Crawford county.

Mention has already been made of the difficulty of readily recognizing the rocks of this, the Millstone Grit formation. In the consideration of sandstone, a stratum occupying a given position may be easily mistaken for one occupying an entirely different position, owing to their great similarity in color, texture and structure, unless their stratigraphical relation can be shown. This, however, is not always possible. In the western part of the county there appears to be a thinning out of those rocks which are conspicuous in the vicinity of Fayetteville, that is, the Archimedes limestone, the Pentremital limestone and the Kessler limestone; while the shales and sandstones immediately associated with them are no longer seen.

At Cincinnati, in 16 N., 33 W., section 29, there is a sandstone ridge which has been cut in two by the creek, while several sandstone-capped hills or mounds extend in a southwest direction. On top of the Boone chert and cherty limestone is the black Fayetteville shale, upon which the sandstone rests, or in some places, as at Hiram Fulmer's, it may rest di-

rectly upon the limestone; at all events it is not far above it. If the sandstone rests upon the Fayetteville shale its position is that of the Batesville sandstone; if it rests on the chert, its position is that of the Wyman sandstone. That it is the latter is not at all probable, for the Wyman sandstone is a comparatively unimportant stratum and never presents the indurated appearance so well shown in the hill above Mr. Fulmer's. Nor can it be the Batesville sandstone unless its lithologic characters have been greatly changed from those in its typical exposures. If, however, the character of the sandstone and its texture be taken into consideration, together with the fact that on one of the mounds in the southwest corner of section 29 there are fragments of a grit similar to, though finer than those found on East Mountain, there is a strong presumption in favor of the thinning out or elimination of the rocks above mentioned. The hill on the right bank of the creek at Cincinnati rises to the height of 75 or 80 feet. At its base is the Boone chert, on its sides the sandstone outcrops, while fragments appear on its top. The resemblance of the sandstone to that of the Millstone Grit formation is striking. Its color, its indurated appearance, and its texture (a fine grit) favor it, yet these characters are not especially distinctive. On the left bank of the creek the rock exposed is quite fine-grained and of a somewhat bluish purple tint.

Southwest of Cincinnati there is shale at the base of Strayhan Mountain in section 36. In ascending the mountain, sandstone fragments occur above the shale, and towards the summit sandstone outcrops, but nowhere has even a trace of limestone been seen.

An ascent of Bell Mountain, in 15 N., 33 W., in the adjacent corners of sections 4, 5, 8 and 9, failed to reveal any limestone above the Boone chert which is well exposed at its base. Above it the Fayetteville shale appears, and still higher there is sandstone debris almost to the summit, and finally sandstone caps the whole.

THE FAYETTEVILLE FAULT IN THE CUT NORTH OF THE FAYETTEVILLE STATION

CHAPTER XIV.

FOLDS AND FAULTS.

While the strata in Washington county lie for the most part in a horizontal position, there is an area showing considerable disturbance extending in a northeast direction from Fayetteville, and in other localities the rocks stand at considerable angles. There is also some evidence of faults.

The Fayetteville fault.—The Archimedes limestone exposed in the ravine south of Evergreen Cemetery in Fayetteville, and the Washington shales shown in the gullies on Dickson street between the University campus and the railway, have a clearly marked dip to the east. The disturbance is, however, most marked in the northern part of the city where the St. Louis and San Francisco Railway passes through a cut made chiefly in the dark Fayetteville shale. Within a hundred feet of the southern end of this cut is a bed of Archimedes limestone which is broken off by a fault, causing it to abut against the black shale.

Above and east of this cut a line of disturbance may be traced in the sandstone along the brow of the adjacent hill in which the outcrop shows a northward dip. In 16 N., 30 W., the northeast quarter of the northeast quarter of section 16, the outcrop of the sandstone turns rather abruptly and bears off in a northeast direction. The amount of displacement or crushing is more strongly shown in the bed of the stream flowing through the south half of the southeast quarter of section 9, immediately north of the above mentioned hill. Here the sandstone is in a vertical position. From this point the outcrop has been traced a short distance to the northeast, disappearing near the north line of Fayetteville, but after a short interval it reappears in the northwest quarter of section 10. From the center of this section, a narrow valley through

which a small stream flows, extends west of north to the section line. On both sides of it hills rise to a considerable height, and on the southwest in some places these hills are quite precipitous. About half way through this pass large masses of sandstone indicate an outcrop which is continued also on the hillside, extending for some distance in a southwest direction. On the opposite side of the valley a corresponding, but more prominently exposed outcrop is up the hill in a northeast direction, the dip being to the northwest.

In 17 N., 29 W., the northwest quarter of section 31, the line of disturbance is again noticed in the displacement of the limestone, probably Pentremital (as the Archimedes limestone has probably thinned out and disappeared) overlying the Fayetteville shale.

The Price Mountain syncline.—A syncline extends through 17 N., 29 W., as follows: The most northern point in which it has been observed is in the southwestern portion of the southeast quarter of the southeast quarter of section 3. Here the trough is filled by a small deposit of much disturbed black shale. Toward the southwest the syncline grows gradually deeper. In the northwest quarter of the northeast quarter of section 10, the black shale is capped with thick layers of the Batesville sandstone. A few rods northeast of this sandstone the Fayetteville shale beds appear, though much lighter than usual. They have been erroneously supposed to contain coal.

In this connection it may be stated that the top of the Boone chert and cherty limestone as it appears under the southeast corner of Price Mountain, is at least 100 feet higher than where it appears on the east side of the shale, three-quarters of a mile farther east. Regarding the syncline there is one point of uncertainty, namely, that in the absence of outcrops it cannot be determined whether there is really a western half to this trough, or whether there may not be a fault in section 16.

Farther to the southwest, in section 20, the existence of a syncline is well shown, for in the southeast of the northwest the coal bed has a dip of 12° to the southeast, while at Lemon's coal bank, in the southeast quarter of the northeast quarter of the same section the dip of the same coal is about 7° northwest. In the southern part of the section this syncline unites with one coming from the east, rendering the geology somewhat complicated. Still farther to the southwest the synclinal structure becomes less conspicuous. Through sections 21 and 22 the syncline follows the course of a creek flowing into White River. This trough is a deep one as will be observed by one standing upon the bluff in the northeast part of section 28, as he looks down into the valley upon the rocks which correspond stratigraphically to those upon which he stands. This syncline has been traced from near where it coalesces with the Price Mountain syncline to the Springdale-Goshen road in section 22.

The White River fault.—There is a line of disturbance or fault extending in an easterly direction from a point not far east of Lemon's coal bank (17 N., 28 W., section 20) to the eastern boundary of the south half of section 18, the effect of which upon the topography has already been referred to under another head.

Northeast of Mr. J. K. Langley's house, in 17 N., 28 W., in the north half of the northwest quarter of section 22, cherty limestone is exposed in the bank of a stream having a steep west-of-south dip. Upon it there is a bed of black shale, followed above by olive-colored shale and light greenish flaggy shale, all dipping west of south at an angle of from 35° to 45°. Above these is an arenaceous limestone, which, while showing abundant evidence of its origin, shows none of its fossils in sufficient detail to enable them to be recognized. The general character of this rock leads to the belief that it is the Pentremital limestone. Further, it is possible that here is a continuation of the disturbed strata which Mr. Harris has traced

into section 18 of this township. This fault crosses the White River on the south side of section 15.

Cato's syncline.—South of Fayetteville, in 16 N., 30 W., section 31, the valley between McCullom's Mountain on the east, and the foot-hills of Kessler Mountain on the west, is a slight syncline through which the Fayetteville-Van Buren road passes for a short distance, near Cato's shop, before it ascends the hill to the south. Standing at the shop and facing southward, the course of the limestone as it emerges from a gorge in McCullom's Mountain may be distinctly seen. In the northwest quarter of the southwest quarter it has reached the level of the road, and is exposed in the bed of a small stream at the point of junction of the "old wire" or Van Buren road and the road to Rieff's Chapel. It also appears for a considerable interval along the latter road as it ascends the hill to the westward; the dip of the limestone, indeed, determines the slope of the hill. From the center of section 31 a short spur projects to the northwest. On its top both sandstone and limestone are exposed, the former overlying the latter which again appears along the roadside at the base of the spur. The following diagram shows the structure and arrangement of the rocks in this basin:

Cato's syncline.

A fault on West Fork.—The bluff of cherty limestone already mentioned as forming the eastern bank of West Fork, in 16 N., 30 W., the southwest quarter of section 25, which, after leaving the river, passes eastward a short distance into the northern part of the northwest quarter of section 36, where it finally disappears, is evidently an upward bulge of that formation, accompanied by faulting, although the amount of displacement has not been great. Under these conditions the

corresponding bluff on the west bank does not, of course, appear.

Cove Creek fold and fault.—From Morrow's, in 14 N., 32 W., section 36, in passing down Cove Creek, the Archimedes limestone occupies a constantly lower position. In the northeast quarter of section 12 it is 130 feet below the Morrow level. At this point it dips to the southeast 10° or 15°, and completely disappears beneath the creek, rising again a quarter of a mile below at an angle of 5°, forming a low bluff on the right bank, while from 10 to 15 feet of Washington sandstone are shown on the left. Continuing down the creek, the gorge becomes canyon-like, being bordered with high bluffs of Archimedes limestone. Those on the right are higher than those on the left, owing to the southeast dip of the rocks. In 13 N., 32 W., near the center of section 23, at Mr. A. C. Clanton's, there is a fault. The limestone is 230 feet below the level at Morrow's, and near at hand is a sandstone presenting the well known appearance of the Washington sandstone. From observations made by Mr. Harris it appears that the Pentremital limestone occurs in the valley in the southern part of section 23, and the Coal-bearing shale in section 26; that in section 34 the outcrops are met in the reversed order, while further south the Archimedes limestone rises to the surface again and continues beyond the borders of the county.

Disturbance at Cincinnati.—In 16 N., 33 W., the strata of the sandstone ridge at Cincinnati have, in places at its base, been very much disturbed. This hill, it will be remembered, is cut in two by Cincinnati Creek. On the right bank, not far from Hiram Fulmer's house, the sandstone dips about 20° in a westerly direction. On the opposite bank, in the rear of James Oates' wagon shop, the dip is from 35° to 45°. At Middleton Jones' house in the northeast corner of the southwest quarter of the southwest quarter of section 29, sandstone exposed in a shallow pit seems to dip in an easterly direction at an angle of about 10°. A short dis-

tance southwest of the house, limestone in the bed of Bound's branch dips north of east at a greater angle. The strata are, however, most disturbed in the northwest quarter of the southwest quarter of this section, as is shown in the right bank of the same stream. Here, almost due west from the Cincinnati public school building, shale is encountered in nearly a vertical position.

Minor effects of lateral pressure are shown in the folding and crushing of the shale exposed in the little stream at the eastern extremity of Spring street, Fayetteville, near Cato's spring.

CHAPTER XV.

ECONOMIC GEOLOGY.

SOILS.

The rocks of Washington county are included in the three groups, limestones, shales and sandstones. By their decay, for the most part in place, soil has been formed. The soils of the alluvial bottoms are formed in the same way, but they have frequently been brought together from considerable distances.

The soil of the Boone chert.—The Boone chert and cherty limestone underlies a large part of the county, both in the north and in the west. With the exception of a strip along the water courses, broken by numerous gulches and ravines, and covered with flinty debris, it furnishes a very fertile soil, notwithstanding the occurrence of cherty fragments in comparatively level areas. Upon it corn and the various grains grow with the greatest perfection. In some localities where the solid rock approaches the surface, the crops suffer from drouth in dry seasons, and from too much moisture in wet seasons. In some localities, too, the finer products of decomposition have been washed out, yet even here, there usually occurs a valuable growth of timber, especially of oak.

The Wyman sandstone that immediately overlies the Boone chert is unimportant economically owing to its limited distribution.

The soil of the Fayetteville shale.—The Fayetteville shale produces alone a soil of moderate fertility, but inasmuch as it occurs in the valleys it is usually enriched by washings from the overlying limestones. In the immediate vicinity of many of the table-topped mountains there are areas more or less covered with coarse fragments which have fallen from the bluffs

above. The soil in such places is unfit for cultivation, but it supports a valuable growth of trees.

In some of the valleys the hard shale approaches so near the surface that the soil is thin, and in some instances entirely wanting. Such valley lands are not to be confounded with alluvial bottoms which occupy similar situations. Where the soil is thicker these valleys make valuable pasture lands and produce occasional crops of hay and grain.

The soil of the Archimedes limestone.—The Archimedes limestone itself does not constitute the surface rock over any considerable area, forming for the most part bluffs and benches around the mountains; and the same is true of the Pentremital and Kessler limestones. Upon these benches the vegetation is so characteristic that one may predict the presence of limestone from a glance at the plant growth. Here are found luxuriant grape vines, walnut, elm, persimmon, locust, wild cherry and other trees which flourish upon calcareous soils. These benches are, however, of small area and in many cases the soil is thin.

The Washington shale and sandstone.—This formation caps many of the table-topped hills near Fayetteville. The sandstone by its decomposition has left a soil upon which fruits are grown with marked success. The apples, peaches and grapes growing upon it are of exceptional size and flavor.

The Coal-bearing shale.—This shale does not cover an extended area. The soil produced by its decomposition resembles other shale soils. On some mountain slopes, where it is enriched by contributions from the Kessler limestone, as on the west side of East Mountain, in 16 N., 30 W., section 10, it is very favorable to the growth of small fruits.

The soils of the Millstone Grit.—The sandstones, shales and grit of the Millstone Grit formation on the summits of the highest mountains, form a soil well adapted to fruit culture.

BRICK CLAYS.*

The soils derived from the sandstones and shales of the county are well adapted to brick making. Rocks of these kinds are most abundant along the faces of the Boston Mountains and its outliers containing the sandstones and shales of the Millstone Grit. The brick clays will be found especially abundant and good on the plains that adjoin the bases of these hills and mountains. Here the soils derived by decay from the higher rocks have accumulated and have been turned over and tempered by natural processes, while the too fat clays have been removed by water. Of course there are many other places than these where the conditions for the formation of good brick earths have prevailed. In places the low lands along streams are covered with brick earth to a depth of from 2 to 10 feet.

The shales of this county, especially the Fayetteville shale and the Coal-bearing shale, are available for the manufacture of vitrified bricks and sewer pipes. None of these shales have yet been utilized for such purposes.

The only brick yards in the county from which the Geological Survey has been able to gather statistics are the two mentioned below.

BRICK STATISTICS OF WASHINGTON COUNTY.

(FOR THE YEAR 1889)

From Vol. I of the Geological Survey's report for 1889:

Place.	No. of Yards.	Make.	Men Employed.	Average Monthly Wages.	Capital.	Output for 1889.	Value at Kiln.	Repressed.
Fayetteville..	2	Hand.	20	$ 650	$ 825 00	450,000	$8 to $10 per M. Repressed, $15.	25,000
Springdale...	2	1 hand. 1 machine	15	390	3000 00	800,000	$6.00	

COAL.

Coal occurs in many localities in Washington county, and while dug at intervals in several places, in only one or two is there anything like a systematic attempt at mining. The bed

*The note upon brick clays is contributed by the State Geologist.

is a thin one, having a maximum thickness of 14 inches, and only where it exceeds 10 inches can it be profitably worked on a small scale and under the most favorable circumstances.

The lower portion of the bed (from 2 to 4 inches) is soft, crumbling into small fragments or slack, while from 7 to 10 inches form a continuous layer. The former is suitable for blacksmithing purposes, the latter for stove and steam heating. It is a bituminous coking coal and contains some iron pyrites.

This coal is delivered in Fayetteville at 12½ cents per bushel for slack, and 18 cents per bushel for stove coal. In this market it is in competition with that brought from the Arkansas Valley and from Kansas. The largest consumers of coal, the electric light station and the State University, do not depend entirely upon the local supply, although it could probably be made sufficient for the home demand.

Lemon's coal bank.—This bank is located in 17 N., 29 W., in the east half of section 20, and is the best developed in the county. The bed is here about 13 inches thick, and is situated 15 feet above the Pentremital limestone.

Statistics of the output of coal in the county are difficult to obtain. The following taken from the record books* of the platform scales, on the public square at Fayetteville, will approximate the output of this bank for the year ending July 1st, 1890. They are given in two-horse wagon loads, the loads probably averaging a little less than a ton. The coal weighed elsewhere or sold in other places than Fayetteville does not appear here :

*The Survey is under obligations to Capt. E. B. Harrison, who placed these books at its disposal.

COAL FROM LEMON'S BANK MARKETED AT FAYETTEVILLE IN 1890.

July, 1889	5	loads
August	19	"
September	25	"
October	47	"
November	58	"
December	46	"
January, 1890	50	"
February	22	"
March	32	"
April	10	"
May	5	"
June	2	"
Total	321	loads (say tons).

Crawford's bank and the old Shepherd bank.—These two coal banks are in the vicinity of Lemon's, the former south-east, and the latter south of it. Their output is small. That of the last named, under the management of Mr. Jenkins, produced, according to the scale books, from 50 to 60 loads during the year ending July 1st, 1890. In this, as in the preceding, there is no estimate for coal sold or weighed elsewhere.

From other sources in the county there were weighed on these scales from 50 to 60 loads during the year, making a total of 375 (estimated) loads disposed of in the principal market, and 400 loads (say tons) the annual output.

Abandoned coal banks and those irregularly worked are mentioned in chapter XI on "the Coal-bearing shale" to which the reader is referred.

Coal at Fayetteville.—Within the corporate limits of Fayetteville coal has been found in two localities; first, near the crossing of Dickson street and the St. Louis and San Francisco Railway in section 16, and second, near the northeast corner of the corporation in section 15.

The coal adjacent to the railway track on the west side occurs in lot of Mr. A. B. Lewis, and extends across Gregg avenue into the lot of Mr. J. H. Williams, both fronting on Dickson street. The bed was opened during the Civil War and the product was used by the Federal army. At the close of the war the work was discontinued and the bed has not since been reopened. Mr. Martin Garrett, who had charge of the excavations, states that the bed was from 9 to 10 inches in thickness and that its dip was to the west. Fortunately an outcrop of this bed was recently struck by laborers engaged in street work, on the southwest corner of Dickson street and Gregg avenue. Here it measures about 4 inches only, but a study of its position made it evident that there exists a small synclinal basin, and this view was confirmed by the outcrop again appearing near the southwest corner of Mr. Williams' lot. This deposit is interesting from the position it occupies, occurring a few feet above the level of the Archimedes limestone. Above it there is a thin sandstone, its dip varying within a short distance between west, south and east. Associated with the coal is the usual accompaniment of fire-clay.

Coal is reported to have been dug in 1865, from what now forms a part of the road-bed of Dickson street, and about 250 feet east of the railway crossing. In grading the street the outcrop was covered. The thickness of the bed could not be ascertained. It is said to have occurred three or four feet below the surface, and to have been nearly level. The coal was used by a blacksmith in a shop close at hand for some time. This bed was struck at a depth of 18 feet in a well on the lot of Mr. Thos. Williams on the north side of Dickson street.

On the lot of Mr. A. S. Vandeventer, a short distance northeast of the depot (northwest quarter of the northeast quarter of section 16), a coal pit was dug some years since. The work was in charge of Mr. H. D. Harmon, now of Fayetteville, from whom much information was obtained. The

total depth excavated was 78 feet, after which a drill was sent down 20 feet further, making the total depth explored 98 feet. The section obtained is as follows:

Surface.	
Gray shale	16 feet.
Black shale	32 feet.
Coal	12 to 14 inches.
Fire-clay	2 feet.
Shale	47 feet.
Total	98 feet.

The coal bed discovered, dips to the south, and was found to be thickest on the north side. The pit is six feet in diameter and from it were taken about twenty-five bushels of coal of good quality. It may be added here that the exploration beneath the coal was made for the purpose of finding a lower and thicker bed supposed by many to exist. This bed has not yet been found, nor is there any evidence that there is such a bed.*

On the southeast quarter of lot 4, block 11, of the Masonic addition, on the south side of Lafayette street (northeast quarter of the northwest quarter of section 15), in the northeastern part of the city, a coal bed 11 inches thick was discovered by George Lindley while digging a pit for a cellar, at a depth of 7 or 8 feet. He dug through gray shales. Clay was encountered both above and below the coal. The coal was tried at the forge and found suitable for welding iron, but not steel. No further developments have been made on this property.

*This coal bed is in close proximity to the Fayetteville fault. While it apparently occurs just above the Archimedes limestone, which is exposed in the adjacent railway cut, it will be noticed that in the 98 feet explored no limestone was encountered. Elsewhere in the county the only bed having such a thickness has been invariably found above the Pentremital limestone and it is probable that the coal here is not an exception. The fact that it occupies a position below the Pentremital limestone outcrops near the Fayetteville school building, can be accounted for on the ground of displacement.

The bed occurs in its normal position, that is, in the Coal-bearing shale overlying the Pentremital limestone.

It has been stated that an outcrop of coal was encountered in making the excavations for the foundation of the public school building on the northern half of the northeast quarter of the northeast quarter of section 16. If so, it was not met with in digging the well just north of the building, which passes through 30 feet of shale and penetrates the Pentremital limestone for 5 feet. Geologically its occurrence here might have been expected, as the position accords with that at Lindley's and elsewhere.

OIL AND NATURAL GAS.

The occurence of oil and gas in the vicinity of Fayetteville has led many to the expectation that something substantial might be realized from it. But the oil indications are based solely upon the occurrence of petroleum in small quantities in the Fayetteville shale, and the gas thus far discovered is evidently from the same source, and likewise of small quantity. Oil may occur in the rocks of any geological horizon, and the mere fact of its presence, is not, as many suppose, *prima facie* evidence of the existence of petroleum in paying quantities. The Fayetteville shale has been pretty thoroughly explored, and there is no substantial reason for expecting it to prove a source of oil.

Natural gas accumulates in a well 145 feet deep, put down some years ago, by Col. J. H. Van Hoose, at his residence on the southeast corner of College avenue and Dickson street in Fayetteville. When the water is removed from the well the gas may be ignited and will burn for a short time with a flame from 3 to 5 feet high. This gas is a good luminant. The well at its beginning passes through the Pentremital limestone and terminates in black shale, which, at the depth given, must be the Fayetteville shale, the Archimedes limestone being here probably very thin, if indeed it is present at all.

A small quantity of gas was encountered in a well on the University grounds, west of the new dormitory building, which had been drilled to the depth of about 200 feet. The flame was very feeble and after a few exhibitions the gas supply failed. The Fayetteville shale is the source of the gas at this place also.

Gas has also been reported in a well drilled in the Fayetteville shale near the steam mill of the Boles-Connor Mercantile Company, at the foot of East Mountain, in 16 N., 30 W., the northwest quarter of the southwest quarter of section 15. Here also the amount was small. This much may be said: if oil and gas are to be expected near Fayetteville they must be looked for elsewhere than in the Fayetteville shale. In this connection attention may be called to the fact that beneath the Fayetteville shale lies a thick limestone—the Boone chert and cherty limestone—and while no surface indications have been seen in the area examined that would warrant the statement that it is either oil or gas-bearing, nevertheless it is just possible that there may be oil and gas in some of the lower limestones. Indications of petroleum are reported as occurring in a well drilled on Dr. E. G. McCormick's place at Prairie Grove, in 15 N., 31 W., the southwest corner of the southeast quarter of the northwest quarter of section 18.

During the summer of 1888, Mr. J. W. McWilliams, a representative of the Union Oil Company, is said to have made an examination of the region within a radius of five miles of Prairie Grove for the purpose of boring for oil. The project has apparently been abandoned on the ground that the company could not lease the amount of land desired.

*On Cove Creek.**—There was more or less excitement a few years ago about oil found on Cove Creek, 14 N., 32 W., section 24, in the northwest corner of the southwest quarter of the northeast quarter. The locality, though not a promising one,

*The note on the oil spring of Cove Creek is contributed by the State Geologist.

has been examined by the Geological Survey. It is known locally as "the oil spring." A town was laid out at this place, and lots were sold, but no buildings were put up. One hole about 12 feet deep and another about 50 feet deep were drilled about 1887, but nothing of importance was developed. It is said that the rope used in drilling these wells was made very oily by the rocks passed through. The rock in which the oil occurs is a soft snuff-colored sandstone having a total thickness of about 50 feet. The base of this sandstone where the so-called oil spring issues is dove-colored. This sandstone is somewhat saturated with petroleum, which can be set free by boiling the rock in water. The water flowing from the spring at the base of this sandstone carries away a preceptible amount of oil.

The section in the vicinity of this oil spring is as follows:

	Estimated thicknesses
Shale	10 feet
Limestone	30 feet
Sandstone	10 feet
Shale	6 feet
Oil-bearing sandstone	50 feet
Black shale	10 feet

Limestone at the base of the section.

This section, however, does not reach to the top of the water-shed in the road between Cove Creek and Sulphur Springs Creek.

It may be well in this connection to correct an error in regard to the relations of the structural geology of this part of the State to this oil-saturated rock on Cove Creek. It has been thought that the rocks in the Boston Mountains dipped north forming a basin in the central or northern part of Washington county, and that the oil-bearing rocks exposed on Cove Creek would therefore be found at a considerable depth in Benton county and in northern Washington county, and rich in oil. This is a grave mistake. The general dip of the

rocks through the Boston Mountains is to the south, though there are many local dips in other directions. Everything in the general geology of Washington county points to the fact that the sandstone in which this oil occurs is cut off along the north face of the Boston Mountains and that the rocks through the central and northern parts of the county all lie below it.

It should be added, moreover, in regard to the Cove Creek oil-bearing sandstone, that it is not a rock from which oil can be expected to flow. It does not contain enough oil to thoroughly saturate it; it cannot, therefore, be expected to yield flowing wells of oil.

LIME.

Lime has been burned in several places in the county, both from the cherty and from the Archimedes limestone, as on the northern bluff of Baxter Mountain; at Mr. W. F. Dowell's, in the southwest quarter of section 29, both in 16 N., 30 W.; in 16 N., 31 W. the northwest corner of section 1; in 14 N., 30 W., the southeast quarter of the northwest quarter of section 5, south of the village of West Fork; and in 17 N., 30 W. near the center of the south half of section 22. Only the kilns of the latter place were in operation in 1888, the others, with the possiible exception of that at West Fork, having been long since abandoned. The rock burned is mostly taken from a quarry in the hillside above the northern kilns, where the rock shows a face 25 ft. high. Although the beds are those of the cherty limestone, the rock is hard, of a gray color, and comparatively free from chert. The quarries above the southern kilns, however, show cherty layers from 2 to 6 inches thick, separating the layers of limestone which are of varying thickness, some being 18 inches or more. Much of the lime manufactured is shipped to Fort Smith and elsewhere on the railway. The kilns and quarries are near the St. Louis and San Francisco Railway, and conveniently situated for shipping purposes.

Lead is occasionally found in Washington county, but in quantities too small to be of any practical importance. Some

LEAD.

prospecting has been done in 16 N., 32 W., section 28, north of Rhea's Mill. The Northwest Arkansas Mining and Milling Company has here sunk five experimental shafts in the Boone chert and limestone. The deepest is down 115 feet. At the time of examination (December, 1889) the shafts were filled with water, but the indications at the dumps did not appear encouraging. A large mass of ore was exhibited at a neighboring house as one of the results of the enterprise. A town site has been laid out here (Leadville) and lots offered for sale or lease. At the present time this can only be regarded as a prospect, and is not to be mistaken for a mine.

BUILDING STONE.

Washington county abounds in rocks suitable for building purposes, but as yet there is small demand for them, and consequently but few quarries opened. Surface rocks, mainly sandstones, are now largely used for foundations for buildings and for chimneys, and as the greater number of buildings are of wood, the better qualities of rocks suitable for sills and trimmings are but little quarried. The following rocks are used to some extent, and some of them may prove to be of great value in the future:

The Boone chert and limestone.—Four miles north of Fayetteville and directly on the line of the St. Louis and San Francisco Railway (17 N., 30 W., section 22) limestone of the Boone chert formation is extensively quarried for burning lime. It is a handsome gray limestone, works well, and would make an excellent building stone. There is exposed in this quarry a face about 25 feet high, free from chert, which does not represent the entire thickness of the bed. The layers vary in thickness from 8 inches or a foot to three or more feet, and can be easily quarried. This rock has also been quarried in the northwest corner of 16 N., 30 W., near Mount Comfort, but its quality as a building stone is reported to be not as good as the above mentioned. In 16 N., 31 W., section 1, a small quan-

tity of this limestone has been taken out along the banks of Hamestring Creek. The exposure is near the water's edge, and the bed is not very thick, but the quality of the rock is good.

This formation, in a condition suitable for quarrying, occurs at various places in this township, along the streams flowing into the Illinois, as well as along the banks of that river itself. Should there be a demand for them many excellent quarries could be opened in this region upon the limestones of this formation.

The Wyman sandstone.—The Wyman sandstone, resting directly upon the Boone chert and cherty limestone, and between it and the Fayettteville shale, has been quarried 2½ miles northwest of Fayetteville in section 7, 16 N., 30 W. The face of the quarry shows a total thickness of 3 feet only. The rock is of a grayish yellow hue on the weathered surface, but of a lighter grayish color on a fresh fracture. It is rather soft and easily worked.

The Batesville sandstone.—The Batesville sandstone will afford good building stone, and may be quarried at almost any point along the west side of the railway from 15 N., 30 W., the center of section 29, a mile and a half north of West Fork village, to Greenland station. In no case is it more than half a mile from the track and usually it is close at hand. Near the center of section 29 the outcrop is exposed on the north bank of a small branch. It is here about 12 feet in thickness, massive and durable, of a brown color on a weathered surface, and gray where freshly broken.

The Archimedes limestone.—The Archimedes limestone has been quarried for burning lime, and with proper selection would undoubtedly furnish good building material, but much of it, as shown by the weathering of detached masses lacks that durability of structure so essential in a good building stone.

The Washington sandstone.—The formation between the Archimedes limestone and the Pentremital limestone furnishes flagging and sandstone. Both have been quarried on the Baxter Mountain, one and a half miles south of Fayetteville, in 16 N., 30 W., section 28. Flagstones of fairly good size and quality have been obtained here and sandstone of a quality suitable for the setting of tombstones, coping, etc. The amount quarried, however, is small.

Other formations occur in this county which would furnish valuable stone, but no quarries of importance have been opened, there being no demand for the rock. A detailed description of the occurrence of these and the preceding will be found in the body of this report.

ROAD-MAKING MATERIAL.

Throughout all the northern part of Washington county, chert, either crushed or broken, furnishes an excellent material for building hard and durable roads. At the present time the roads of the county, especially those on which the travel is heavy, are in a deplorable condition and an effort should be made to improve them. Crushed chert would give Fayetteville excellent streets and that too at no great expense. An abundance of this material can be had within five or six miles of the city and at localities easily reached by the railway. Good streets ought to be among the first municipal improvements, and instead of wasting time and money on temporary road-work, as is now the custom, there should be built each year, within the corporation at least, a permanent piece of road, even if short, and in so doing there will be found no material equal to crushed chert. The St. Louis and San Francisco Railway has brought just such material from Missouri for ballast on its road-bed in the Fayetteville cut and at the station.

Wherever the shales of Washington county are sandy they will be found to make good road material; the argillaceous shales however should be avoided in road building.

CHAPTER XVI.

THE COLUMNAR SECTIONS.

The columnar sections along an approximately north-south line in 29 W., 16 and 17 N., are brought together on Plate I, for the purpose of showing the varying thicknesses of the rocks within a few miles. The location of each section, and the names of the various horizons are given on the plate.

The vertical adjustment of these sections has no reference to differences of elevation, but is entirely arbitrary. The vertical scale is 120 feet to one inch.

PLATE I.

SECTION I.

Compiled from the notes of G. D. Harris, on 16 N., 29 W., sections 29, 30, 31 and 32.

Sandstone*	70	feet.
Kessler limestone	10	"
Coal-bearing shale	75	"
Pentremital limestone and included sandstone	70	"
Sandstone, passing into shale below (Washington formation)	75	"
Archimedes limestone	35	"
Batesville sandstone	45	"
Fayetteville shale	35	"

SECTION II.

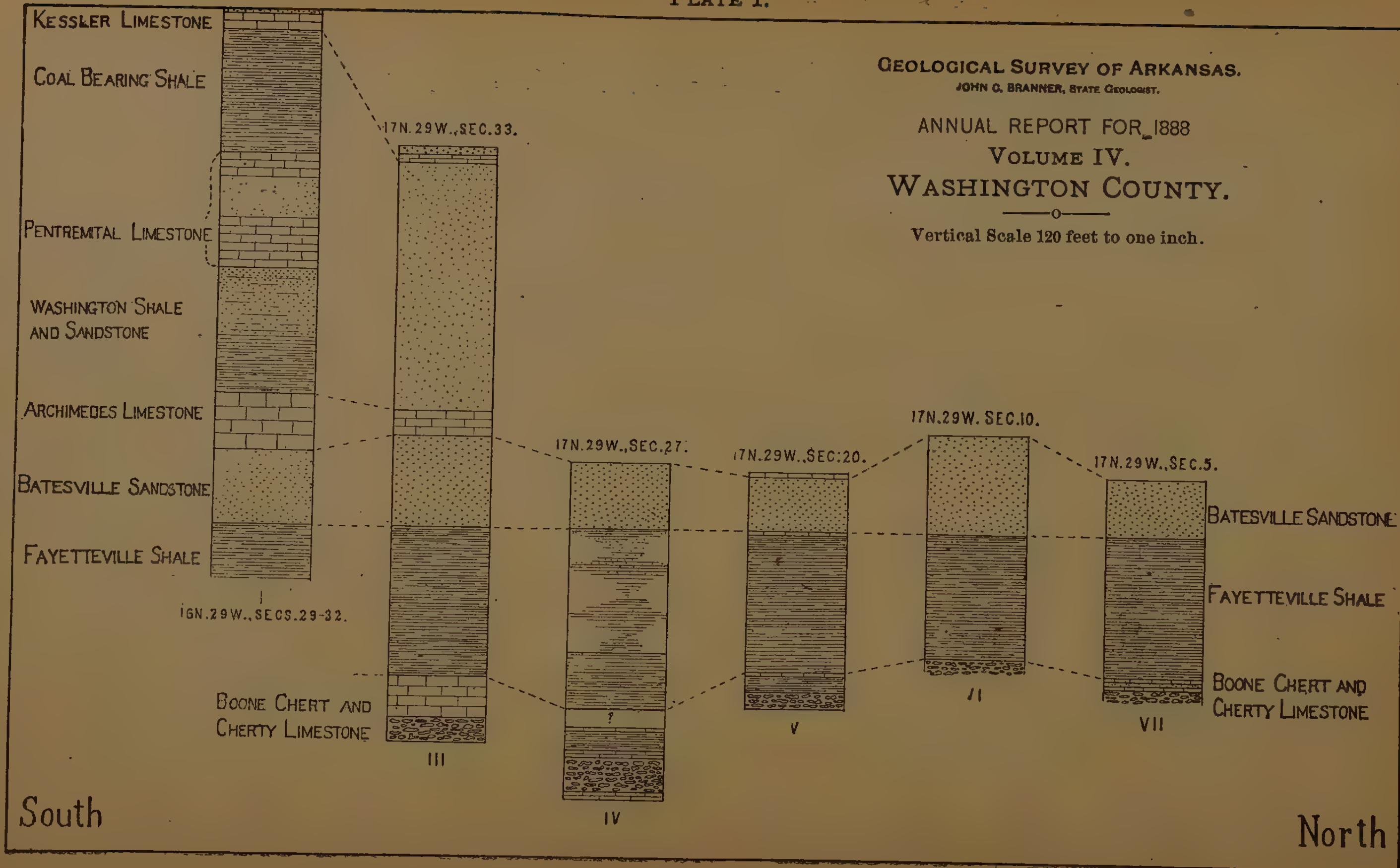
(This section is not given in the plate.)

The upper portion of Round Mountain, in 16 N., 29 W., section 14, by G. D. Harris.

Sandstone	30	feet.
Sandstone, forming highest bench	35	"
Concealed	100	"
Shale	70	"
Sandstone	?	"
Pentremital limestone	?	"

*All of this section above the Kessler limestone is omitted from the page plate

PLATE I.


GEOLOGICAL SURVEY OF ARKANSAS.
JOHN C. BRANNER, STATE GEOLOGIST.
ANNUAL REPORT FOR 1888
VOLUME IV.
WASHINGTON COUNTY.
Vertical Scale 120 feet to one inch.
KESSLER LIMESTONE
COAL BEARING SHALE
PENTREMITAL LIMESTONE
WASHINGTON SHALE AND SANDSTONE
ARCHIMEDES LIMESTONE
BATESVILLE SANDSTONE
FAYETTEVILLE SHALE
16N.29W., SECS.29-32.
I
17N.29W., SEC.33.
III
BOONE CHERT AND CHERTY LIMESTONE
17N.29W., SEC.27.
IV
17N.29W., SEC.20.
V
17N.29W. SEC.10.
II
17N.29W., SEC.5.
VII
BATESVILLE SANDSTONE
FAYETTEVILLE SHALE
BOONE CHERT AND CHERTY LIMESTONE
South
North

SECTION III.

Compiled from the notes of G. D. Harris, on 17 N., 29 W., the southwest quarter of section 33.

Grits	5	feet.
Kessler limestone	5	"
Sandstone, representing the Coal-bearing shales, Pentremital limestone and Washington formation	145	"
Archimedes limestone	15	"
Batesville sandstone	55	"
Fayetteville shales	90	"
Boone chert and cherty limestone	25	"
Concealed by talus	15	"

Level of White River.

SECTION IV.

A generalized section in 17 N., 29 W., the northwest quarter of the northwest quarter of section 27, by G. D. Harris.

Batesville sandstone				40	feet.
Concealed	75	feet	Fayetteville shale	136	"
Black shales	35	"			
Concealed	10	"			
Black shale	12	"			
Black limestone	4	"			
Chert				20	"
Gray limestone				5	"

SECTION V.

In 17 N., 29 W., the northeast quarter of the northeast quarter of section 20, by G. D. Harris.

Pentremital limestone				3	feet.
Washington sandstone				33	"
Sandy layers of the Archimedes limestone				2	"
Black shale	85	feet	Fayetteville shale	97	"
Black limestone with fossils	2	"			
Black shale	10	"			

Boone chert and cherty limestone at the base.

SECTION VI.

Harp's Bluff in 17 N., 29 W., the southwest quarter of section 10, by G. D. Harris.

Batesville sandstone	60 feet.
Fayetteville shale	75 "

Boone chert at the foot.

SECTION VII.

West end of Webber Mountain, 17 N., 29 W., northern part of section 5, by G. D. Harris.

Batesville sandstone	35 feet.
Fayetteville shale	85 "

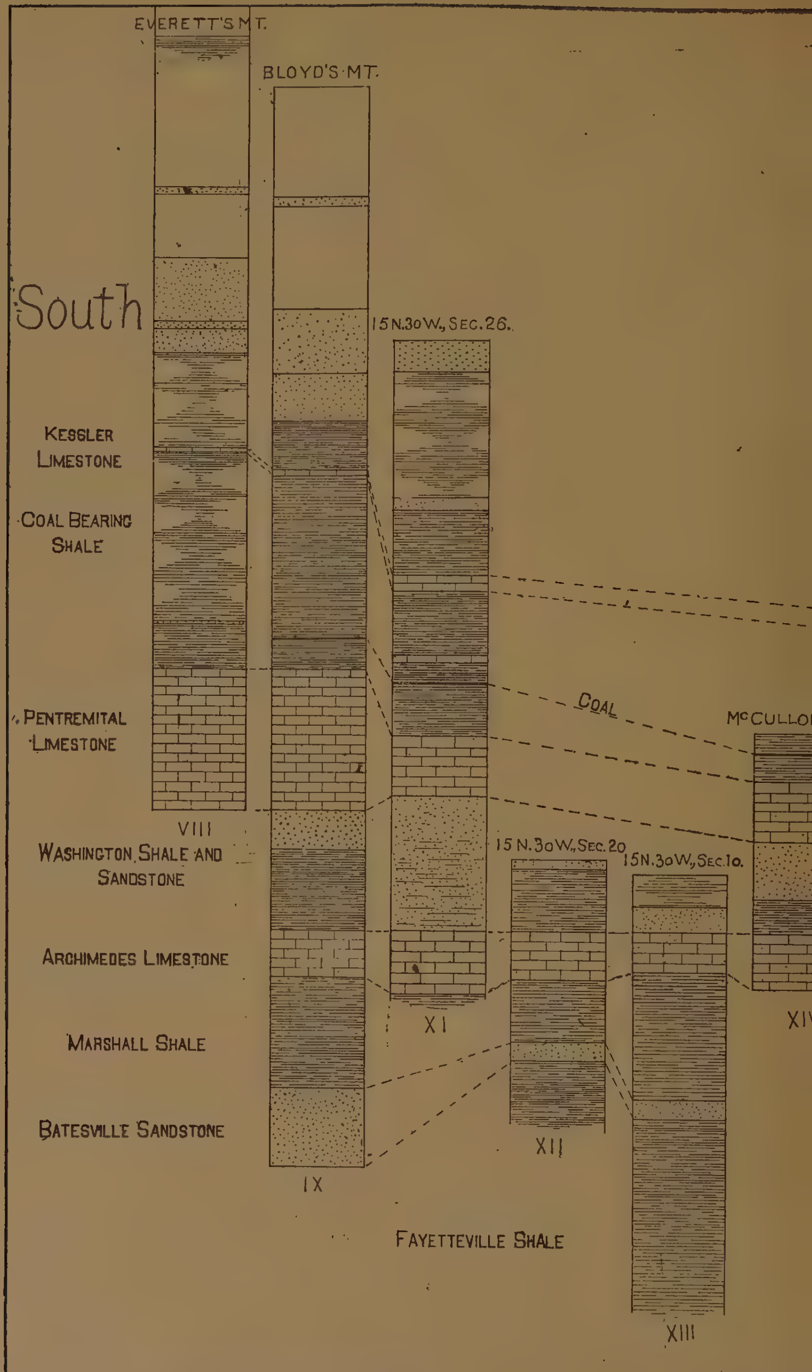
Level of the plain.

Limestone	Well.	Boone chert and limestone.
Sandstone		
Limestone		
Chert		

PLATE II.

On plate II the sections are also arranged along an approximately north-south line through 31 W., from 15 to 17 N., a distance of 22 miles. This plate shows the varying thickness and characters of the several beds and how the Archimedes limestone thins out to the north and disappears entirely about township 17.

The vertical arrangement of the sections on the plate is arbitrary. The vertical scale is 120 feet to 1 inch.


EVERETT'S MT.
BLOYD'S MT.
South
15 N.30 W., SEC. 26.
KESSLER LIMESTONE
COAL BEARING SHALE
COAL
MC CULLO
PENTREMITAL LIMESTONE
VIII
WASHINGTON SHALE AND SANDSTONE
15 N.30 W., SEC. 20
15 N.30 W., SEC. 10.
ARCHIMEDES LIMESTONE
XI
XI
MARSHALL SHALE
XII
BATESVILLE SANDSTONE
IX
FAYETTEVILLE SHALE
XIII

GEOLOGICAL SURVEY OF ARKANSAS.

JOHN C. BRANNER, STATE GEOLOGIST.

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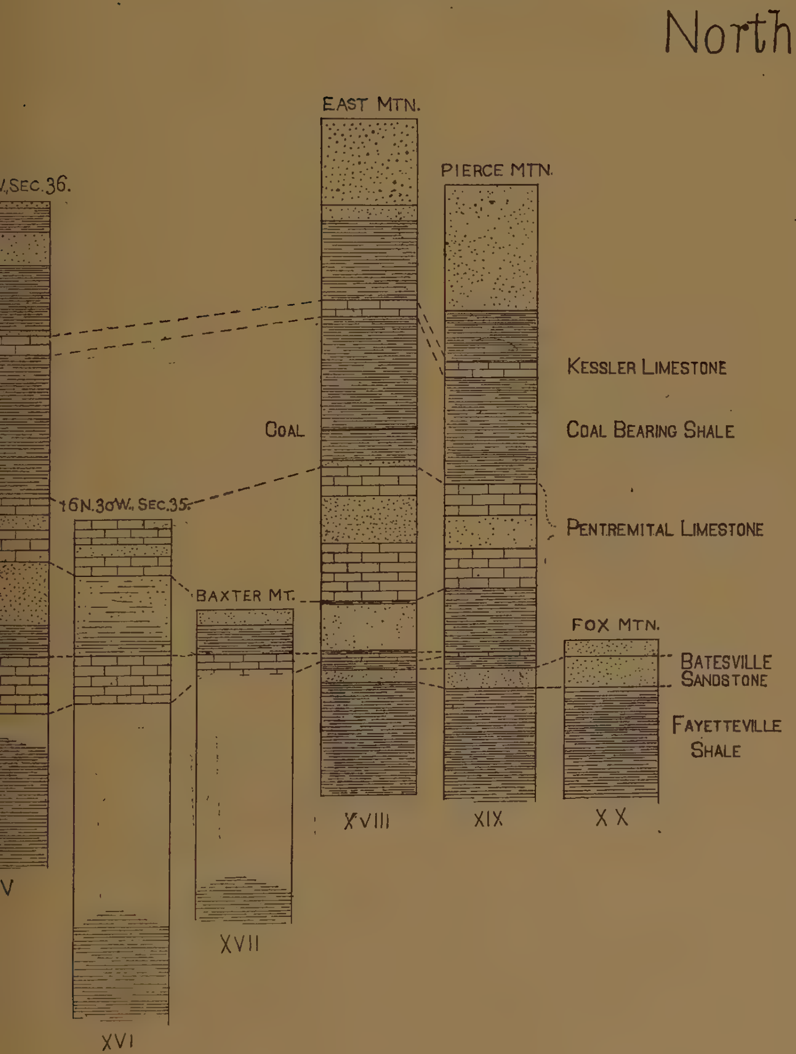
WASHINGTON COUNTY.

Vertical Scale 120 feet to one inch.



SECTION VIII.

Everett's or Sugar Mountain, beginning at the mouth of Mill Creek in 14 N., 30 W., section 16.

Sandstone	40 feet.	Millstone grit formation, 500 ft.	
Broken sandstone outcrop			
Sandstone	30 "		
Sandstone outcrop			
Concealed	29 "		
Gray shale	1 "		
Sandstone	8 "		
Concealed	122 "		
Shale			
Concealed	100 "		
Grit fragm'ts on a rock shelf, concealed	40 "		
Sandstone, bench	60 "		
Shale	60 "		
Kessler limestone			3 feet.
Shale	107 feet.	Coal-bearing shale	137 "
Sandstone	2 "		
Shale	28 "		
Pentremital limestone			90 "

Mill Creek.

SECTION IX.

Bloyd's Mountain, from notes on 15 N., 30 W., sections 32 and 33, and on 14 N., 30 W., section 4.

Millstone grit formation	236 feet.
Kessler limestone	4 "
Coal-bearing shale	105 "
Coal	10-11 inch.
Coal-bearing shale	20 feet.
Pentremital limestone	90 "
Washington shale and sandstone	75 "
Archimedes limestone	30 "
Marshall shale	70 "
Batesville sandstone	50 "

Bed of the west Fork of White River.

SECTION X.

(Omitted from the plate.)

The bluff and hill north of the town of West Fork and near the center of section 32, 15 N., 30 W.

Washington shale and sandstone	20	feet.
Archimedes limestone	35	"
Marshall shale	70	"
Batesville sandstone		

Bed of the west fork of White River.

SECTION XI.

An approximate section from the Archimedes limestone into the Millstone Grit formation, 15 N., 30 W., near the center of section 26, by Mr. Crozier.

Millstone grit and Kessler limestone	200	feet.
Coal-bearing shales	50	"
Pentremital limestone	45	"
Washington shale and sandstone	90	"
Archimedes limestone	40	"

SECTION XII.

The hill and bluff adjacent to the St. Louis and San Francisco Railway, in 15 N., 30 W., the southeast quarter of section 20.

Washington shale and sandstone	40	feet.
Archimedes limestone	30	"
Marshall shale	40	"
Batesville sandstone	12	"
Fayetteville shale	10	"

SECTION XIII.

Hill in 15 N., 30 W., the southwest quarter of the northeast quarter of section 10, with an estimated thickness of the strata, by Mr. Crozier.

Washington formation	12	feet.
Archimedes limestone	30	"
Marshall shale	100	"
Batesville sandstone	12	"
Fayetteville shale	150	"

Level of west fork of White River.

SECTION XIV.

McCullom's Mountain, in 16 N., 30 W., the southeast quarter of section 31, and the southwest quarter of section 32.

Coal	6–8	in.
Pentremital limestone		
Washington shale and sandstone	57	feet.
Archimedes limestone	35	"

SECTION XV.

Kessler Mountain, near the township line, between 16 N., 31 W., the southeast quarter of section 36, and 15 N., 31 W., section 1.

Millstone Grit formation	79	feet.
Kessler limestone	15	"
Coal-bearing shales	90	"
Pentremital limestone	40	"
Washington shale and sandstone	60	"
Archimedes limestone	35	"
Concealed	70	"

SECTION XVI.

Western end of Brooks Mountain, in 16 N., 30 W., the northwest quarter of section 35.

Pentremital limestone	35 feet
Washington shale and sandstone	50 "
Archimedes limestone	25–30 "
Concealed	200 "

SECTION XVII.

Bluff on the north side of Baxter Mountain, in 16 N., 30 W., the northeast quarter of the northeast quarter of section 28.

Sandstone, 9 feet. Shale, 19 feet. } Washington shale and sandstone	28 feet.
Archimedes limestone	9 "
Talus of sandstone	
Black shale in bed of Town Branch—Fayetteville shale	

SECTION XVIII.

East Mountain, Fayetteville, from notes on 16 N., 30 W., sections 11, 14, 15 and 16.

Millstone grit formation	115 feet.
Kessler limestone	8 to 12 feet.
Coal-bearing shale, including 8 to 11 inches coal seam	90 "
Pentremital limestone	85 "
Thin bed of shale. Sandstone, 30 ft. Pebbly shale, 2 ft. } Washington shale and sandstone	32 "
Archimedes limestone, very impure	5 "
Thin bed of shale followed by Batesville sandstone	
Fayetteville shale	

SECTION XIX.

On the south side of Pierce Mountain, in 16 N., 30 W., sections 12 and 13.

Millstone grit formation	80 feet.
Shale / Kessler limestone / Coal-bearing shale	110 "
Upper division of the Pentremital limestone	20 "
Sandstone	20 "
Lower division of the Pentremital limestone	25 "
Shale	40 "
Archimedes limestone	
Marshall shale	
Batesville sandstone	15 "
Fayetteville shale	

Bed of the West Fork of the White River.

SECTION XX.

Fox Mountain, in 17 N., 29 W., the southwest quarter of section 19, by G. D. Harris.

Sandstone	10 feet.
Sandstone	20 "
Fayetteville shale	70 "

Level of the plain.

SECTION XXI.

(Omitted from the Plate.)

Boston Mountains, through Morrow's coal bank, in 14 N., 32 W., section 36.

Sandstone		120 feet.
Kessler limestone		10 "
Shale 40 ft. / Coal 11 to 14 in. / Shale 20 ft.	Coal-bearing shale	61 "
Limestone 10 ft. / Shale 20 ft. / Limestone 40 ft.	Pentremital limestone	70 "
Sandstone? 50 ft. / Yellow sndstn 30 ft. / Gray shale 15 ft.	Washington shale and sndstn	95 "
Archimedes limestone		30 "
Shale		

CHAPTER XVII.

GENERAL CONSIDERATIONS.

Organization.—When organized in 1828 Washington county included that portion of Northwest Arkansas lying north of township 12 and west of range 25. From this area there were subsequently formed Benton county on the northwest, and portions of Carroll on the northeast, Madison on the east and Franklin on the southeast.

The county, as constituted at present, is bounded on the north by Benton county, on the east by Madison, on the south by Crawford, and on the west by Indian Territory. It is estimated to include an area of about 950 square miles, or 608,000 acres, of which 429,133 acres appear on the records for 1888, and 439,058.49 acres on those for 1889, as taxable.

Resources.—The resources of Washington county are well shown from the following tables, taken from the assessment books for the years 1888 and 1889:

	1888.	1889.
Value of land, with structures thereon	$ 1,550,370	$ 1,627,018.00
Value of city or town lots	475,775	579,785.00
Value of railway property, as assessed by the State Board	454,670	391,471.80
Value of personal property	1,764,440	1,731,952.00
Grand total	$ 4,245,255	$ 4,330,226.80

Population.—The total population of Washington county, according to the census, is as follows:

In 1870	17,266
In 1880	23,844
In 1890	32,021

Cities and towns.—The cities and towns of the county, with their population (estimated), are as follows:

(1)	Fayetteville	3,000
(2)	Springdale	1,000
(3)	Prairie Grove	500
(4)	Boonsboro	250
(5)	Cincinnati	250
(6)	West Fork	200
(7)	Evansville	150

Other towns are: Farmington, 5½ miles southwest of Fayetteville; Dutch Mills, 26 miles southwest; Greersburg, 31 miles southwest; Elm Springs, 12 miles northwest; Durham, on the St. Paul branch of the St. Louis and San Francisco railway, 17 miles southeast; Goshen, 10 miles northeast, and Winslow, at the entrance of the long tunnel through the Boston Mountains, 22 miles south of Fayetteville. In addition to these, there are usually smaller settlements at the less important railway stations and near the various post-offices, as at Greenland (Staunton post-office), Woolsey's (Pitkin post-office), Brentwood, Wedington, Sulphur City and Salem (Sexton post-office).

Railways.—The railways of the county are three in number, namely: The Texas branch of the St. Louis and San Francisco railway ("Frisco"), which passes through it from north to south; the Fayetteville and Little Rock, now operated as the St. Paul branch of the Frisco, extending in a southeast direction from Fayetteville to St. Paul in Madison county, a distance of 35 miles, of which 20 miles are in Washington county; and the Pacific and Great Eastern Railway, a contemplated east and west through line, of which but six miles have been constructed, extending from Fayetteville to Wyman, on the White River.

Timber.—For some years past there have been large shipments of white oak timber (white oak, post oak and burr oak are included in this term) from Fayetteville in the form of railway supplies, *i. e.*, cross-ties, fence posts, lumber and piling. This business reached its maximum in the years 1887 and 1888,

for which time the value of the material marketed is estimated at over two millions of dollars. By far the larger part of these supplies were from the line of the Fayetteville and Little Rock Railway (St. Paul branch of the St. Louis and San Francisco Railway), then recently opened. It must be understood, however, that while the above figures represent the value of the timber sent from Fayetteville as a point of shipment, they do not represent the value of the product of Washington county alone, but include that of Madison county, adjacent to the above mentioned railway.

In addition to the supplies enumerated, there have been shipped, from time to time, small quantities of ash lumber for car finishings, as well as walnut and cherry, the latter chiefly to St. Louis.

Farm products.—The more common products are corn, wheat and oats, which do well, while the forage plants, clover and the grasses, usually attain an exceptional growth. All kinds of vegetables are easily cultivated, although the importtation of cabbage and potatoes must be noted. These two form an apparent exception, not thriving as well here as in a cooler climate. The establishment of canning plants at Springdale, West Fork, Prairie Grove and Boonsboro bear witness to the abundance and quality of tomatoes, sweet corn, peas, beans and fruit.

Fruit.—Washington county is gaining a widespread reputation for the abundance and the quality of its fruit, especially for its apples. The autumnal shipment of the latter from Fayetteville in 1888 is estimated at 18,000 bushels or 6,000 barrels. In addition there have been shipped from Fayetteville of the same year's product, not less than 350,000 pounds of evaporated fruit, apples and peaches. Cherries, pears and plums thrive, but peaches have a tendency to blight. Of the smaller fruits, strawberries, blackberries and raspberries are very successfully grown, and are now being placed to some extent on the Kansas City market. Experiments with the

grape bear every evidence of success, as shown in the vine yards of Mr. J. E. Trahin, east of Fayetteville, and Mr. L. Archais west of that city.*

Dr. J. F. Simonds has well stated the conditions prevailing here when he says: "Washington County has a most fortunate combination of soil and altitude, seasonable rains and unobstructed sunshine, for the production of a great variety of fruit, of the finest flavor, in immense quantities, and with the greatest certainty and least labor. Our latitude (36°) affords positive security against the long continued cold and deep freezing so destructive to fruit crops in the northern states. While our altitude (about 1500 feet) above the sea level, gives us almost certain immunity from late spring frosts which make such havoc with the prospects and profits of fruit raisers in the valleys and other regions which have no such protection."†

Educational advantages.—The State University, known as the Arkansas Industrial University, is located at Fayetteville. This institution has a faculty of twenty professors and teachers, and an attendance of over 500 students. The interest of Washington county and the city of Fayetteville in the higher education is shown by the fact that the former voted $100,000 and the latter $40,000 to secure the location of this institution. Fayetteville has also a good public school system. Of other institutions mention may be made of Cane Hill College at Boonsboro, and the excellent schools at Prairie Grove, Cincinnati, Springdale and West Fork. Schools are also maintained for a portion of the year at least, in the numerous districts in which the county is divided. The people are awake to the necessity of improving the educational advantages of their immediate neighborhoods, as is shown by the increase in the number of districts voting for the school tax.

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*Experiments are being made with a large number of varieties. Those known to do well are Ives Seedling, Cynthiana and Norton's Virginia.

†The Resources and Advantages of Washington County, Arkansas. By Dr. J. F. Simonds, p. 12.

Weather records.—The only weather records known to have been kept in Washington county are the observations made by the officer of the United States Signal Service at Winslow since July, 1889, and those of a more general nature kept by Mr. W. M. Bozarth, of Fayetteville.

Summaries of both these records are given here:

Weather record kept at Fayetteville.

(By Mr W. M. Bozarth.)

1888.

	MONTHS.	Clear.	Cloudy.	Rain.	Snow.	No Record.
1	January	16	7	2	6	
2	February	9	13	3	4	
3	March	13	8	7	3	
4	April	17	6	7	....	
5	May	17	2	9	....	3
6	June	16	1	12	....	1
7	July	23	....	8	....	
8	August	21	....	10	....	
9	September	18	....	1	Frost 17	11
10	October	7	1	1	Frost 13, 20 & 21	18
11	November	5	10	6	2	7
12	December	12	13	5	....	1

1889.

	MONTHS.	Clear.	Cloudy.	Rain.	Snow.	No Record.
1	January	13	8	7	4	
2	February	15	3	4	6	
3	March	18	6	7	....	
4	April	17	5	8	....	
5	May	13	12	6	Frost 3d, 4th, 30th & 31st.	
6	June	6	6	3	....	16
7	July	13	6	12	....	
8	August	23	3	4	....	1
9	September	10	7	10	Frost 26th, 27th	3
10	October	4	3	4	....	20
11	November	12	5	8	1	
12	December	18	11	2	....	

Summary of observations at Winslow.

(By the United States Signal Service.)

MONTHS.	Maximum Temperature.	Minimum Temperature.	Mean Temperature.	Precipitation.
1889—				
July	89	57	76.9	6.49
August	87	55	72.9	1.41
September	83	36	65.0	7.15
October	80	40	57.8	4.57
November	69	17	41.1	5.84
December	70	19	53.0	0.47
1890—				
January	66	10	39.9	5.26
February	72	4	45.1	5.01
March	66	8	44.2	5.26
April	75	45	57.4	7.52
May	80	42	64.8	6.57
June	91	60	75.7	4.82
July	84	68	77.7	0.51
August	84	65	74.5	10.52
September	80	42	67.1	8.26
October	84	33	56.8	3.13

Publications relating to Washington county.—The following is a list of the published books and papers that relate directly to Washington county:

1. First Report of a Geological Reconnoissance of the Northern Counties of Arkansas; by David Dale Owen, Little Rock, 1855. [Washington county, pp. 110-123.]

2. Second Report of a Geological Reconnoissance of Arkansas; by David Dale Owen, Philadelphia, 1860. [Washington county coal at Fayetteville, p. 299; at Male's coal bank, p. 300; at Woton's coal bank, headwaters of Lee Creek, p. 301.]

3. Resources of the state of Arkansas with descriptions of counties, railroads, mines, and the city of Little Rock; by James P. Henry, Little Rock, 1873. [Washington county, pp. 128–129.]

4. The Resources and Advantages of Washington County, Arkansas, as a Place of Residence, and for the Invest-

ment of Capital; by J. F. Simonds. [Published by the Fayetteville Industrial Club, Fayetteville, 1885, p. 24]

5. Products and Resources of Arkansas; compiled by D. McRae, by direction of Hon. Simon P. Hughes, Governor of Arkansas, Little Rock, 1885. [Washington county, pp. 131-133.]
6. Washington County, Arkansas; by M. L. DeMalher, the Daily Arkansas Gazette, Little Rock, June 14, 1888.
7. History of Benton, Washington, Carroll, Madison, Crawford, Franklin and Sebastian Counties, Arkansas (known as the "History of Northwest Arkansas"). Chicago: The Goodspeed Publishing Co., 1889. [Washington county, pp. 137-323.]

CHAPTER XVIII.

THE FAYETTEVILLE-HUNTSVILLE SECTION.

BY GILBERT D. HARRIS.

The part of this section lying between Fayetteville and Richland Creek was compiled from the detailed map of this region by Prof. Simonds and the writer, and is believed to be as accurate as if it had been run out consecutively for the express purpose of constructing a section. From this point to its eastern terminus the writer followed carefully the section lines. Elevations were determined by the use of the aneroid barometer, whose readings were checked by a series of simultaneous observations made by Prof. Simonds at Fayetteville.

At the range line between 16 and 17 W. an offset of one mile was made in order to bring the section through the town of Huntsville.

The profile section is intended to give the main features and stratigraphic relations of the various formations between Huntsville and Fayetteville.

*The Boone chert and cherty limestone.**—The characteristics of this formation apparently remain constant throughout the entire section.

The Fayetteville shale.—The above remark is equally applicable to the Fayetteville shale.

The Batesville sandstone.—When distinct from the Washington shale and sandstone the Batesville sandstone varies considerably in thickness. In 17 N., 29 W., it forms cliffs from 30 to 70 feet in height.

The same deposit in Pierce Mountain is probably from 10 to 15 feet thick; in 16 N., 29 W., perhaps no more than 4 feet;

*This formation is described in Prof. Simonds' report, chapter III of this volume.

in 16 N., 27 W., section 5, about 2 feet; one and a half miles northwest of Huntsville, about 5 feet; four miles southeast of Huntsville it is not represented. In localities where the Archimedes limestone is wanting, this bed and the Washington sandstone form one continuous series of flaggy sandstone.

The Archimedes limestone.—This formation varies greatly in lithological characters and in thickness, but is readily distinguished from the other limestones herein described by the prevalence of its characteristic genus—*Archimedes.* In Prof. Simonds' section of East Mountain it is represented as being 3 to 5 feet in thickness; in 16 N., 29 W., sections 7 and 18, it is somewhat thinner.

In both cases, however, the upper layers consist of a reddish argillaceous matrix filled with large, dark bluish pebbles, fragments of crinoid stems, corals, etc.

In 16 N., 28 W., section 2, it is represented only by a few, somewhat calcareous thin layers in sandstone.

It is doubtfully represented in 16 N., 27 W., section 5, by a thin layer of reddish shale filled with crinoid stems and dark colored pebbles.

North of Huntsville, perhaps one and three-fourths miles, there is an exposure of Archimedes limestone on the north bank of Holeman's Creek, where it resembles in every particular the same formation in 16 N., 29 W., sections 7 and 18. Between this point and Huntsville, it is exposed at many places in the little ravines that open into the valley of Holeman's Creek. In these places it is rarely over three feet thick, and is argillaceous and sometimes arenaceous.

Southeast of Huntsville about three and a half miles, this formation is well displayed at Elm bend and in the north bank of a small stream which flows eastward into War Eagle Creek; it is here light gray in color, with no pebbly or argillaceous layers, but is often quite cherty. It presents similar characteristics at the ford of the War Eagle; and again on the right bank of this creek, some distance to the east, where it forms a

bluff over sixty feet in height. In this vicinity, as has already been stated, the Batesville sandstone is not represented.

Washington shale and sandstone.—The lithologic characters of the deposit that immediately overlies the Archimedes limestone are subject to extreme variations; at one locality it is a firm sandstone; at another it forms flaggy layers; again, soft gray shales; and finally, black slaty or fissile shale.

For the character of the Washington shale and sandstone near Fayetteville, see Prof. Simonds' section.

Three and a half and four miles southeast of Huntsville the sequence of its subdivisions, from below upwards, are as follows:

Black shale	13 feet.
Arenaceous shale	1–2 foot.
Shale above	2–3 feet.
Flaggy sandstone	50–100 feet.

Pentremital limestone.—Like the Archimedes limestone, this varies greatly in thickness and general appearance. Throughout this entire section, however, it is easily identified by: (1) Its position, (2) abundance of its Pentremital remains, (3) its generally great thickness, (4) the arenaceous character of its lower layers, (5) absence of *Archimedes.*

The characteristics of the Pentremital limestone about Fayetteville are given in Prof. Simonds' description in chapter x.

After leaving 16 N., 30 W., going eastward along the line of this section, the first exposures of this limestone are met with in 16 N., 28 W., sections 5 and 8. It is here well developed and is immediately underlain by thick beds of calcareous sandstone. Between this point and Huntsville good exposures are numerous.

In the vicinity of Huntsville it may be observed for some distance along all the highways that radiate out in various directions. Particularly noticeable are its outcrops along the Huntsville-Aurora road as it is seen jutting out here and there just beneath the heavy ledge of Millstone grit, and finally ap-

pearing in great force in the road bed about two and a half miles southeast of Huntsville, where it is no less than sixty feet thick.

Millstone grit (proper).—This consists of a yellowish sandstone in which are imbedded white quartz pebbles of a flattened oval form, ranging in size from a hickory nut downwards. Though varying greatly in thickness, this formation is well represented in 16 N., 27 W., sections 5 and 8; 17 N., 26 W., section 32; 16 N., 26 W., section 5; and especially in the bluffs along Town Branch, east of Huntsville. About a half mile west of this village, it is apparently represented by a few large white quartz pebbles in the uppermost layer of the Pentremital limestone; a half mile farther west it expands from 0 to 12 feet in thickness within a distance of forty yards.

The Coal-bearing shale.—The Coal-bearing shale usually occupies the horizon of the Millstone grit, when the latter is wanting. At Fayetteville and various other localities it contains a thin bed of coal.

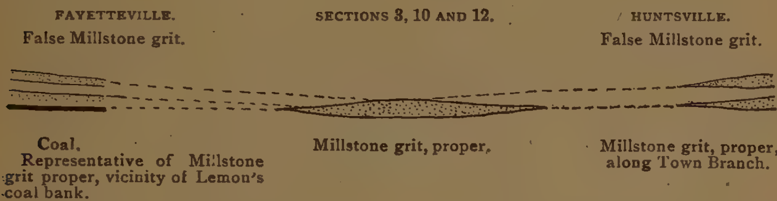
The Kessler limestone.—This limestone is found near Fayetteville, overlying the Coal-bearing shale. Near Huntsville, it is wanting, its place being occupied by flaggy sandstone.

The false Millstone grit.—As shown on the accompanying section, this deposit occurs on the hilltops around both Fayetteville and Huntsville. It consists for the most part of ferruginous sandstone, in which are imbedded numerous angular crystal clear quartz pebbles, rarely over an eighth of an inch in diameter.

North of Fayetteville, in the vicinity of Lemon's coal bank, a similar deposit is often found immediately overlying the coal. This, according to the writer's interpretation, is the representative of the Millstone grit (proper) which appears farther east (16 N., 27 W., sections 5 and 8), along the line of the section under consideration. This view is sustained not only by the fact that the two occupy practically the same horizon, both appearing immediately upon, or only a short

distance above the Pentremital limestone, but by the apparent intergrading of the two varieties of grit in sections 3 and 10, 16 N., 27 W., as well as in the northeast of the northeast of section 12, 16 N., 27 W.

The following diagram will serve to illustrate the foregoing statements:



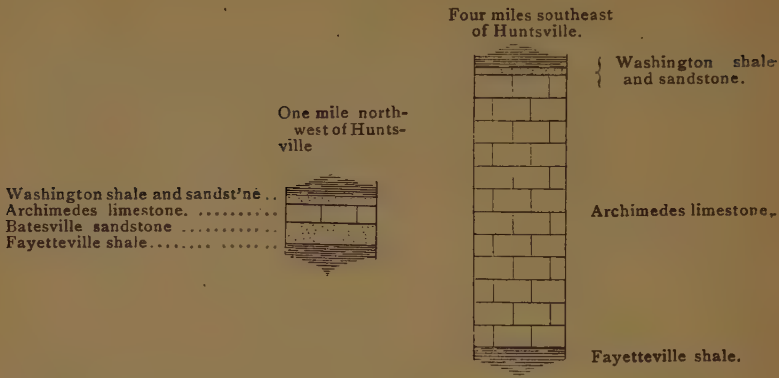
As stated above there is a close lithological resemblance between the false Millstone grit and the beds that apparently represent the Millstone grit (proper) in the vicinity of Lemon's coal bank. So noticeable is this that the writer is inclined to believe that the two formations so distinct in the vicinity of Huntsville, but merging together towards the west, may likewise be intimately associated near the coal bank referred to, though their representative horizons are again far apart at Fayetteville.

REMARKS.

While proceeding along the course of this section, one is constantly struck with the evidence presented on all sides, showing that when these various formations were being deposited there was land at no great distance to the north, while the deep sea covered the region towards the south.

This is shown by the fact that the limestone formations thicken and become purer southward, while the Millstone grit thins out in the same direction. In fact, there is a general increase of calcareous and argillaceous matter, going south, while the arenaceous and coarser materials expand towards the north.

The following two sections will serve to illustrate the point in question:



Sections showing the different thicknesses of the same beds within a distance of five miles north-south.

A LIST OF THE PLANTS OF ARKANSAS.

By John C. Branner and F. V. Coville

INTRODUCTION.*

AID RECEIVED.

Professor Coville's work.—When the work of the Geological Survey of the State was begun in 1887, several collateral branches of work were taken up with the purpose of adding to our knowledge of the natural history of the State in whatever way such additions could be made without interfering with the more direct and specific duties of the Survey. Among other things a list of the plants of the State was begun and added to by the various members of the Survey. In the summer of 1888, Professor F. V. Coville, then Instructor in Botany at Cornell University, now of the Botanical Division of the United States Department of Agriculture at Washington, was induced to spend some months in the State, partly for the purpose of giving proper direction to the botanical work. And it is to Professor Coville's efforts, both in the field and in the laboratory, more than to any other one person's labors, that the present list owes its value.

His field work was done in the vicinity of Little Rock and in Independence county where he made collections of plants and studied their relations to soils and to geologic structure.

*By John C. Branner.

He has gone carefully over the lists of Nuttall and Lesquereux, has examined all the published papers that relate to or bear upon the botany of the State, and incorporated whatever there is of value in making up such a list in this table. He has also pointed out errors in the old lists and appended notes on many of the species that cannot fail to be of great service in future work on the botany of Arkansas.

It was originally my intention to publish the list as Professor Coville's, but having traveled over every part of the State and having thus had better opportunities for observing its flora I have made additions and changes in it for which he ought not to be held responsible. I have preserved, however, the order of arrangement and all his notes substantially as he handed them in. I wish therefore to give him credit for whatever there may be good in the list and to take upon myself the responsibility for all its defects.

Professor Coville's interesting paper on the general topic of the flora of the State is appended to the list as a proper resume of the subject, while his review of the bibliography of Arkansas is inserted with this introductory part of the paper.

Professor Call's aid.—Besides the botanists referred to in Professor Coville's notes (Nuttall, Lesquereux, Harvey and Butler) several of the assistants of the Geological Survey have cordially co-operated with me in making the list as nearly complete as possible. Professor R. Ellsworth Call, who was engaged for several months on the geology of Crowley's Ridge, has added his observations upon the botany of that portion of the State. Professor Call has a chapter upon the forest trees of eastern Arkansas in Volume II of this Survey's report for 1889, chapter XXIII, pp. 183-202.

Professor Simonds.—Professor Frederic W. Simonds, formerly at the State University, kindly examined the herbarium collected by Professor Harvey and now at that institution, and a number of valuable observations have thus been added by Professor Simonds to the list.

Professor Blatchley.—Professor Willis S. Blatchley, of Terre Haute, Indiana, an experienced botanist and observer, was engaged by the Geological Survey for some months in Independence county, and in studying the borders of the highlands from the Missouri line just west of the St. Louis, Iron Mountain and Southern Railway to near Beebe. During that time and in the region mentioned he made a number of valvable additions to the list, and in other cases confirmed observations made by others.

Professor McNeill.—Professor Jerome McNeill of the State University at Fayetteville, has also made some additions to the list from the flora of Washington county.

Mr. D'Ailly.—Mr. Richard D'Ailly of Little Rock has for many years given more or less attention to the botany of the state. He has kindly given us the benefit of his knowledge in preparing the list. The species reported by him are in his private herbarium in this city.

Authorities—There is some difficulty in giving authorities for reporting the plants mentioned in the list. The more common ones have been observed and recorded by so many of those who have co-operated with us in preparing the list that it has become impracticable to mention all the names in connection with each species. When a plant has been reported by three separate observers therefore the names of the authorities have been omitted altogether. No doubt this omits a certain class of desirable information from the list, but there are urgent reasons for encumbering it as little as possible.

Value of the plant list.—This list makes no pretension to being anything more than a bare list. It gives nothing or next to nothing about geographic distribution, and does not even pretend to say whether the plants mentioned are rare, common or abundant. But aside from its scientific interest, even such a bald list of the native plants of the state has important economic value.

The number of grapes that grow wild through the state, and the great size of the vines, suggest as plainly as Nature can suggest anything, that our state is unusually well adapted to grape culture.

Much might be said of the distribution of the timber and of the industries of the state based upon it. Such a paper, however, to have any value, would require much more time and labor in gathering the statistics of geographic distribution, manufacture and exportation, than it has been possible for the Geological Survey to give the subject. This is a work, however, which ought to be done, and which must be done when we cease to deal in generalities and undertake to let the world know specifically what our natural resources are in this direction. Our endless forests of yellow pine, our vast cypress swamps, our sweet gum, oak, holly, hickory, cedar and other forest trees are but a part of the plant wealth of the state. More modest but quite as useful plants are usually overlooked, Our abundant tannin producing plants are not utilized; forage plants, of which we have not a few, contribute their share to our natural advantages; plants of medicinal properties abound, while our wild flowers vie in beauty with the brightest and fairest in the world.

It is hoped and believed that the publication of this list will encourage the study of botany here for its own sake, and that this list will be greatly lengthened and improved by local observers. There is perhaps no state in the Union having so rich and varied a flora, no state in which such large numbers of subtropical plants meet equal numbers of northern ones, as in Arkansas.

BIBLIOGRAPHY AND EXPLORATIONS.*

The work of Nuttall.—The botanical work done in Arkansas up to 1887, when the work of the present Geological Survey began, was confined to a few individuals and a few exploring parties. The earliest explorer was Thomas Nuttall, one of the

*The bibliography has been prepared by Professor Coville.

prominent early American naturalists. He spent several years in the territory, as it then was, most of his time being occupied in botanical observations. The results of these observations were not published as a report, but at odd times and in different places. They are all long out of print.

"Journal of Travels Into Arkansas Territory, 1819: By Thomas Nuttall, p. 236, Phila., 1821." This book has not been obtained by the writer, and no sketch of its contents can be given.

"A Description of Some New Species of Plants Recently Introduced Into the Gardens of Philadelphia, from the Arkansas Territory: By Thomas Nuttall. Jour. Phil. Acad. Sci., Vol. II, pp. 114-123; Phila., 1821." Twelve species of Arkansas plants are described.

"Description of Two New Genera of the Natural Order Cruciferæ: By Thomas Nuttall. *Ibid.*, Vol. V, pp. 132-135." The plants are *Selenia aurea* and *Streptanthus maculatus;* the latter from Red River, the former from the Arkansas.

"Collections Toward a Flora of the Territory of Arkansas: By Thomas Nuttall. Transactions of the American Philosophical Society, Vol. II (New Series), pp. 139-203. Philadelphia, 1837." There are included two fungi, and several Pteridophyta, the remainder being flowering plants, some newly described. The paper appears to be a list of all the plants, so far as it goes, found in Arkansas up to the time of publication. But the Polypetalæ and several orders of the Gamopetalæ (one of the Compositæ) are omitted.

The work of Lesquereux.—In the year 1859, Prof. Leo Lesquereux was engaged by the geological survey then being carried on by the state under the direction of David Dale Owen, to make an examination of the botany, both fossil and recent. Only the last three months of the year were spent in the field. Lesquereux's report is published in the "Report of the Second Geological Survey of Arkansas, pp. 295–399. Philadelphia, 1860." It includes a sketch of the botanical features

of several of the northern counties; of the vegetation of the Mammoth Spring, of Fulton county; some general notes on distribution, and a list of the plants collected by himself and Nuttall.

Pacific Railway reports.—In the year 1853 the exploring party of the Pacific railroad survey passed through the state, by way of the Arkansas River. A brief sketch of the route is given in the survey's catalogue of plants. Those of Arkansas are however omitted.

Sketch of the route from Napoleon to Fort Smith. By J. M. Bigelow. Pacific R. R. Reports, Vol. IV, p. 1.

Butler's list.—In the Botanical Gazette for May, 1877 (Vol. II, p. 104), a nominal list of 101 species of plants found in Arkansas, not included in Lesquereux's catalogue, is given, by George D. Butler, of Limestone Gap, Indian Territory.

Harvey's work.—From 1875 to 1885, Professor F. L. Harvey, then at the Arkansas Industrial University at Fayetteville, made extensive collections of plants, which have found their way to many of the larger herbaria of this country and Europe. His private herbarium was purchased by the University, where it is preserved. A complete account of his collections has never been published, but the herbarium at Fayetteville has been carefully examined and its Arkansas species included in the plant list of the state, the nomenclature being revised. Professor Harvey has, however, written several shorter articles that refer to the botany of the state.

"The Forest Trees of Arkansas, American Journal of Forestry, June and July, 1883." Also reprinted separately, pp. 1–20. This article gives a list of 120 species of arboreal plants, with an account of their distribution in the state.

Many notes on the occurrence and distribution of species are given by Professor Harvey in the Botanical Gazette, as follows: Vol. V, pp. 15, 39, 84, 91, 139; Vol. VI, pp. 189, 213, 215, 230, 273; Vol. VIII, p. 355; Vol. IX, pp. 195, 196; Vol. X, p. 279.

The article, in two parts, beginning on page 188 of Vol. VI, is an enumeration of the ferns of Arkansas, with their distribution. The same author has also a note on the flora of Arkansas in the American Naturalist, Vol. XV, p. 388.

Other sources of information.—Some notes on the size and occurrence of a few trees are given by John A. Warder in the Botanical Gazette, Vol. VI, p. 188.

In the Report on the Forests of North America, Vol. IX, by Professor Charles S. Sargent, of the Tenth Census of the United States, pp. 543, 544, is given a short sketch of the forests of Arkansas; an estimate of the standing short-leaved pine (*Pinus mitis*); and a map of the pine, hardwood and prairie lands of the state, probably prepared for that volume by Professor Harvey.

In 1884, the firm of Higgins & Bro., of St. Louis, Mo., published a series of maps of the state, one of which gives outlines of the hardwood, pine and prairies of the state, the areas being compiled from the notes of the original United States land surveys.

Mr. G. W. Letterman, of Allenton, Missouri, and a few of Professor Harvey's former students at the Industrial University, have also done some botanical work in the state.

Nomenclature.—The oldest specific or varietal names are used in this list (not going back of Linnæus' Species, 1753) under whatever genera they may originally have been employed. On this principle Professor William Trelease, Director of the Missouri Botanical Gardens at St. Louis, has kindly revised the list. It is but just to Professor Trelease to add, however, that the time that could be allowed for this revision was too short to admit of the necessary investigations in all cases, so that a few plants appear under questionable names current in Gray's Manual or other works in general use.

A LIST OF THE PLANTS OF ARKANSAS.

RANUNCULACEÆ.

Clematis, L.
- *crispa*, L.; d'Ailly.
- *ochroleuca*, Ait.; Lesquereux.
- *pitcheri*, Torr. & Gr.
- *viorna*, L.
- *virginiana*, L.

Thalictrum, L.
- *purpurascens*, L. Probably all reported as *T. cornuti* by d'Ailly, Harvey and Lesquereux belongs here.

Anemonella, Spach.
- *thalictroides*, (L.) Spach.

Anemone, L.
- *acuta* (Pursh.) Britton, Mem. Torrey Club, II, 42; Lesquereux.
- *decapetala*, L. Perhaps two species have been reported under the name *A. caroliniana*.
- *hepatica*, L.; Lesquereux. This may be *A. acuta*.
- *heterophylla*, Nutt. in Torr. & Gr., H., I, 12, as synonym of a variety; Nuttall, d'Ailly.
- *virginiana*, L.

Myosurus, L.
- *minimus*, L; Nuttall, d'Ailly.

Ranunculus, L.
- *abortivus*, L.
  - *var. grandiflorus, Engelm;* Harvey.
  - *var. harveyi;* Gray.
  - *var. micranthus*, (Nutt), Gray; Harvey.
- *fascicularis;* Muhl.

multifidus, Pursh.; Lesquereux; d'Ailly as *R. purshii.* For remarks on nomenclature, see Greene, Pittonia, II, 8.

muricatus, L; d'Ailly.

oblongifolius, Ell.; d'Ailly, Harvey.

parviflorus, L; d'Ailly, Harvey.

pennsylvanicus, L. f.; Harvey.

pusillus, Poir.

recurvatus, Poir. Along Polk Bayou near Batesville, Coville.

sceleratus, L.; Harvey.

septentrionalis, Poir. Includes most if not all that has passed for *R. repens*.

trachyspermus, Engelm.; Harvey. Out of the range assigned this species by Dr. Gray.

Caltha, L.

palustris, L.; Lesquereux.

Hydrastis, L.

canadensis, L.

Isopyrum, L.

biternatum, (Raf.), Torr. & Gr.; Pitcher, Harvey.

Aquilegia, L.

canadensis, L.

Delphinium, L.

azureum, Michx.

consolida, L.; Harvey.

tricorne, Michx.

Cimicifuga, L.

racemosa, (L.); Nutt.

MAGNOLIACEÆ.

Magnolia, L.

acuminata, L. Abundant on Crowley's Ridge, Call.

glauca, L.; Lesquereux.

macrophylla, Michx.; Crowley's Ridge, Call.

tripetala, L. (M. umbrella, Lam.); d'Ailly, Harvey.

Liriodendron, L.
tulipifera, L. Abundant along Crowley's Ridge.

ANONACEÆ.

Asimina, Adans.
triloba, (L.); Dunal.

MENISPERMACEÆ.

Menispermum, L.
canadense, L.

BERBERIDACEÆ.

Podophyllum, L.
peltatum, L.

NYMPHÆACEÆ.

Brasenia, Schreb.
nymphiodes, (Thumb.) Baillon. (*B. peltata*, Prush.).
Castalia, Salisb.
odorata, (Dryanda), Greene; Nuttall, Lesquereux.
reniformis, (D. C.) Swamp near Little Rock, Coville.
Nymphæa, L.; Emend.
advena, Solander.
Nelumbo, Adanson.
lutea, (Willd.) Pers.

PAPAVERACEÆ.

Argemone, L.
mexicana, L.
Stylophorum, Nutt.
diphyllum (Michx.), Nutt; Lesquereux.
Sanguinaria, L.
canadensis, L.
Dicentra, Borck.
cucullaria, (L.), DC.; Butler, Harvey. For a possible explanation of the origin of the original name of Borckhausen, *Diclytra*, see Hitchcock, Trans. St. Louis Academy, V., 477.

Corydalis, DC.

aurea, (Michx.) Willd; Nuttall, Torr. & Gray.

crystallina, Engelm; Harvey.

flavula, (Raf.) DC.; d'Ailly.

micrantha, (Engelm.) Gray; Harvey.

CRUCIFERÆ.

Nasturtium, R. Br.

amphibium, (L.) R. Br.; Nuttall. It is doubtful whether Nuttall found the true *N. amphibium*, Coville.

lacustre, Gray; Harvey.

officinale, R. Br.; Lesquereux.

sessiliflorum, Nutt. On muddy banks of the Arkansas River near Little Rock, Coville.

sinuatum, Nutt.

tanacetifolium, (Walt.) Hook. & Arnott.; Torrey and Gray.

Arabis, L.

canadensis, L.

confinis, S. Watson. Limestone cliffs in the northwest, Harvey (as *A. drummondii.*)

hirsuta, (L.) Scop.; Lesquereux, Harvey.

lævigata, (Muhl.) Poiret.

ludoviciana, Meyer; Torr. & Gr., Harvey. The name *A. virginica* (L.) may perhaps be adopted for this, since it is in part the *Cardamine virginica*, of L. Sp., 656.

perfoliata, Lam.; Harvey.

Streptanthus, Nutt.

maculatus, Nutt.; Nuttall, Sabine.

Thelypodium, Endl.

pinnatifidum, (Michx.) S. Watson; Pitcher.

Cardamine, L.

bulbosa, (Schreb.) BSP. (*C. rhomboidea*, DC.); d'Ailly, Harvey.

hirsuta, L.; Nuttall, d'Ailly.
laciniata, (Muhl.) Wood; Harvey, under *Dentaria*.
Leavenworthia, Torr.
aurea, Torr.; Leavenworth.
michauxii, Torr.; Harvey.
Selenia, Nutt.
aurea, Nutt.; Nuttall, Harvey.
Lasquerella, S. Wats. (*Vesicaria* of most writers).
gracilis, (Hook.) S. Wats.; Nuttall, Leavenworth. Perhaps extralimital, Coville.
nuttallii (Torr. & Gr.), S. Wats.; Nuttall, Leavenworth.
repanda, (Nutt.) S. Wats.; Pitcher.
Draba, L.
brachycarpa, Nutt.
caroliniana, Walter,
var. micrantha, Gray; Nuttall.
cuneifolia, Nutt.; Nuttall, Harvey.
Sisymbrium, L.
pinnatum, (Walt.) Greene; (*S. canescens*, Nutt).
Erysimum, L.
asperum, DC.
var. arkansanum, Gray; Nuttall.
cheiranthoides, L.; Nuttall.
Capsella, Moench.
bursa-pastoris, (L.) Moench.
Senebiera, Poir.
didyma, (L.) Pers.
Lepidium, L.
menziesii, DC.; Harvey.
virginicum, L.

CAPPARIDACEÆ.

Cleome, L.
pungens, Willd.; d'Ailly.
serrulata, (Pursh.) Torr. & Gr.; Nuttall, James.

Cleomella, DC.

angustifolia, Torr.; James.

Gynandropsis, DC.

pentaphylla, (L.) DC.; Sandy river banks in northwest Arkansas, Harvey.

Cristatella,

erosa, Nutt. Probably extralimital, Coville.

jamesii, Torr. & Gr.; James.

Polanisia, Raf.

dodecandra, (Michx.) BSP.

CISTACEÆ.

Helianthemum, Pers.

capitatum, Nutt.; Nuttall, Leavenworth.

Lechea, L.

leggettii, Britt. & Holl. (*L. minor*, Lam.); Torr & Gr., Lesquereux.

minor, L. (*L. major*, Michx).

tenuifolia, Michx. Dry sandy woods, at the south end of Main street, Little Rock, Coville; Harvey.

VIOLACEÆ.

Viola, L.

blanda, Willd.

hastata, Michx.; Lesquereux.

palmata, L.

var. cordata, (Walt.) BSP.; Harvey.

var. cucullata, (Ait.) Gray.

pedata, L.; Lesquereux, Harvey.

pedatifida, Don. (*V. delphinifolia*, Nutt.); Harvey.

pubescens, Ait.

sagittata, Ait.

tricolor, L.,

var. arvensis, DC.

Ionidium, Vent.

polygalæfolium, Vent.; Nuttall.

Solea, Ging.

concolor (Forst.), Ging.; Nuttall.

POLYGALACEÆ.

Polygala, L.

ambigua, Nutt.; Grand Prairie, Harvey.

fastigiata, Nutt,; Lesquereux.

incarnata, L.

lutea, L.; Lesquereux.

nuttallii, Torr. & Gr.; Grand Prairie, Harvey.

sanguinea, L.

senega, L. Low ground in northwest Arkansas, Harvey.

verticillata, L.

Krameria, L.

secundiflora, DC.; Nuttall. Probably extralimital, Coville.

CARYOPHYLLACEÆ.

Saponaria, L.

officinalis, L.

Silene, L.

antirrhina, L.; Lesquereux, Harvey.

regia, Sims.; Harvey.

stellata, (L.) Ait., f.

virginica, L.

Lychnis, L.

githago (L.), Lam.

Cerastium, L.

nutans, Raf.; Butler.

viscosum, L.; Harvey.

vulgatum, L.

Stellaria, L.

macropetala, Torr. & Gr.

nuttallii, Torr. & Gr.; Nuttall, Pitcher.

prostrata, Baldw.; Harvey.

Arenaria, L.

michauxii (Feuzl.), Hook. f.; Torr. & Gr., Lesquereux.

patula, Michx. (*A. pitcheri*, Nutt.)

serpyllifolia, L.; Harvey.

tenella, Nutt.; Nuttall.

Sagina, L.

decumbens (Ell.), Torr. & Gr.; Harvey.

procumbens, L.; d'Ailly, Harvey.

PORTULACACEÆ.

Portulaca, L.

oleracea, L.; Lesquereux, d'Ailly.

pilosa, L.

Talinum, Adans.

teretifolium, Pursh.

Claytonia, L.

caroliniana, Michx.

virginica, L.

ELATINACEÆ.

Bergia, L.

texana, Seub.; Harvey.

HYPERICACEÆ.

Ascyrum, L.

crux-andreæ, L.

stans (Pers.), Michx.

Hypericum, L.

adpressum, Bart.; Nuttall, Lesquereux.

canadense, L.; Lesquereux.

cistifolium, Lam.; Leavenworth, Lesquereux.

densiflorum, Pursh; Grand Prairie, Harvey.

drummondii (Grev. & Hook.); Torr. & Gr.

ellipticum, Hook.; Harvey.

gentianoides (L.), BSP. Frequent in very thin soil on flat-topped rocks throughout Independence county, Coville (as *H. nudicaule*, Walt.); Harvey (as *H. sarothra*, Michx.).

gymnanthum, Engelm. & Gr. Grand Prairie, Harvey.

lobocarpum, Gattinger. Found by Dr. H. E. Hasse, formerly of Little Rock, "in wet pine barrens," *fide*, Dr. August Gattinger in "The Tennessee Flora;" on hilltops in Independence county, Coville.

maculatum, Walt.; also as *E. corymbosum*, Muhl.; Harvey.

mutilum, L.

prolificum, L.; Lesquereux, Harvey.

Elodea, Juss.; emend.

petiolata (Walt.), Pursh.

MALVACEÆ.

Althæa, L.

officinalis, L.

Malva, L.

rotundifolia, L.

Callirrhoe, Nutt.

digitata, Nutt.

involucrata (Nutt.), Gray; Harvey.

papaver (Cav.), Gray; Leavenworth.

Sida, L.

spinosa, L.

Abutilon, Gærtn.

avicennæ, Gærtner.

Modiola, Mœnch.

caroliniana (L.), Don. (*M. multifida*, Mœnch.); d'Ailly, Harvey.

Hibiscus, L.

grandiflorus, Michx. A specimen has been received from Col. W. B. Clark, Beebe, White county. Coville.

militaris, Cav.; Harvey.

TILIACEÆ.

Tilia, L.

americana, L.

pubescens, Ait.; Coville.

LINACEÆ.

Linum, L.

lewisii, Pursh. (*L. Perenne*, L. var.)

rigidum, Pursh; Harvey.

striatum, Walt.; Harvey.

sulcatum, Riddell; Butler.

virginianum, L.

GERANIACEÆ

Geranium, L

carolinianum, L.

maculatum, L.

Oxalis, L.

corniculata, L.

var. (?), *macrantha*, Trel.

var. stricta (L.), Sav.

violacea, L.

Impatiens, E.

aurea, Muhl. (*I. palliaa*, Nutt.)

biflora, Walt. (*I. fulva*, Nutt.)

RUTACEÆ.

Xanthoxylum, L.

clava-herculis, L.

var. fruticosum, Gray; Nuttall.

Ptelea, L.

trifoliata, L.

SIMARUBACEÆ.

Ailanthus, Desf.

glandulosus, Desf.

AQUIFOLIACEÆ

Ilex, L.

cassine, L. (*I. dahoon*, Walt.); d'Ailly.

decidua, Walt.; Lesquereux, Harvey at Texarkana.

opaca, Ait. Forests of holly are especially abundant in the southern part of the State, where trees two feet in diameter are common.

verticillata (L.), Gray; Lesquereux.

vomitoria, Ait. (*I. cassine*, Walt.); Lesquereux, Harvey.

CELASTRACEÆ.

Euonymus, L.

americanus, L. Hot Spring county, d'Ailly; between Bradford and Denmark, Independence county, Coville.

atropurpureus, Jacq.

RHAMNACEÆ.

Berchemia, Neck.

scandens (Hill), Trelease; (*B. volubilis*, DC.)

Rhamnus, L.

caroliniana, Walt.

Ceanothus, L.

americanus, L.

VITACEÆ.

Vitis, L.

æstivalis, Michx. This includes *V. labrusca* of Torrey and Gray, d'Ailly, and Lesquereux, so far as Arkansas is concerned.

cordifolia, Michx.

riparia, Michx.

vulpina, L.

Cissus, L.

incisa (Nutt.), Ch. Desm. (*Vitis incisa*, Nutt.)

Ampelopsis, Michx., emend.

arborea, (Willd.) Michx.; Torrey & Gray, Coville (as *Vitis arborea*); d'Ailly (as *V. bipinnata*).

Parthenocissus, Planch.

quinquefolia (L.), Planchon. (*Ampelopsis quinquefolia*, Michx.)

SAPINDACEÆ.

Sapindus, L.

marginatus, Willd.

Æsculus, L.

pavia, L.

Acer, L.

rubrum, L.

saccharinum, L. (*A dasycarpum*, Ehrh.)

saccharum, Marsh. (*A. saccharinum*, Wang.)

var. nigrum (Michx. f.), Britt.

Negundo, Mœnch.

aceroides, Mœnch.

Staphylea, L.

trifolia, L.

ANACARDIACEÆ.

Rhus, L.

aromatica, Ait.

copallina, L.

(*cotinoides*, Nutt. Found as yet only over the border in Indian Territory, by Nuttall, Coville.)

glabra, L.

radicans, L. (*R. toxicodendron, L.*)

typhina, L.

LEGUMINOSÆ.

Baptisia, Vent.

australis (Willd), R. Br.; Torr. & Gray, Leavenworth.

lanceolata (Walt.), Ell.; Nuttall.

leucantha, Torr. & Gr.

leucophæa, Nutt.

sphærocarpa, Nutt.
villosa (Walt.), Nutt.; Nuttall.

Crotalaria, L.
sagittalis, L.

Trifolium, L
arvense, L.; Lesquereux.
carolinianum, Michx.; Torrey & Gray.
pratense, L.
procumbens, L.; d'Ailly.
reflexum, L.
repens, L.

Hosackia, Dougl.*
sericea (Pursh.), (*H. purshiana*, Benth.)

Psoralea, L.
cuspidata, Pursh ; Leavenworth.
digitata, Nutt.
linearifolia, Torr. & Gr.; Beyrich.
melilotoides, Michx.
simplex, Nutt.; Nuttall.
tenuiflora, Pursh.

Amorpha, L.
canescens, Pursh.
fruticosa, L.
pamiculata, Torr. & Gr.; Leavenworth.

Dalea, L.
alopecuroides, Willd.
aurea, Pursh ; Leavenworth.
lanata, Spreng.; Nuttall, Harvey.
laxiflora, Pursh ; Leavenworth. The earliest name is *D. enneandra*, Nutt. in Fraser's Catalogue, No. 30, accompanied by partial description.

Petalostemon, Michx.
candidus (Willd.), Michx.

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*For a discussion of the North American species under the genus *Lotus*, with their synonyms when so placed, see Greene, Pittonia, II., 133.

decumbens, Nutt.; Nuttall.
gracilis, Nutt. Dry sandy woods, at the south of Main street, Little Rock, Coville.
multiflorus, Nutt.; Nuttall, Leavenworth.
phleoides, Torr. & Gr.; Leavenworth.
violaceus (Willd.), Michx.

Indigofera, L.
anil, L.; Butler.
leptosepala, Nutt.; Nuttall, James.

Tephrosia, Pers.
onobrychoides, Nutt.
spicata (Walt.), Torr. & Gr.
virginiana (L.), Pers.

Wistaria, Nutt.
frutescens (Walt.), Poir.

Robinia, L.
pseudacacia, L.

Sesbania, Pers.
macrocarpa, Muhl.

Astragalus, L.
canadensis, L.
caryocarpus, Ker.
distortus, Torr. & Gr.
mexicanus, DC.
nuttallianus, DC.

Glycyrrhiza, L.
lepidota, Pursh; Torr & Gray.

Æschynomene, L.
virginica (L.), (*A. hispida*, Willd.); Lesquereux, Harvey.

Stylosanthes, Sw.
biflora (L.), BSP. (*S. eliator*, Swartz.)

Desmodium, Desv.
canadense (L.), DC.; Lesquereux, Harvey.
canescens (L.), DC.; Lesquereux.

ciliare (Muhl.), DC.; Harvey.
cuspidatum (Muhl.), Hook.
dillenii, Darl.; Harvey.
grandifolium (Walt.), DC.; Lesquereux, Harvey (as *D. acuminatum*.)
lævigatum (Nutt.), DC.; Torrey & Gray.
marilandicum (L.), Boot.; Harvey.
nudiflorum (L.), DC.; Lesquereux, Harvey.
paniculatum (L.), DC.; Lesquereux, Harvey.
pauciflorum (Nutt.), DC.
rigidum (Ell.), DC.; Leavenworth.
rotundifoilum (Michx.), DC.; Harvey; about Bradford, Blatchley.
sessilifolium (Torr.), Torr. & Gr.; Torrey and Gray, Lesquereux.
strictum (Pursh.), DC.; Northwest Arkansas, Harvey.
viridiflorum (L.), Beck.

Lespedeza, Michx.
frutescens (Willd.), Ell. (*L. capitata*, Michx.)
hirta (L.), Ell.; Lesquereux, Harvey.
repens (L.), Bart.
reticulata (Muhl.), Pers.; Harvey.
striata, Hook. & Arn.
stuvei, Nutt.
violacea (L.), Pers.

Vicia, L.
americana, Muhl.; Lesquereux, Harvey.
caroliniana, Walt.; Lesquereux.
leavenworthii, Torr. & Gr.; Leavenworth.
micrantha, Nutt.; Nuttall, d'Ailly.

Lathyrus, L.
pusillus, Ell.
venosus, Muhl.; d'Ailly.

Centrosema, DC.
virginianum (L.), Benth.; Harvey.

Clitoria, L.

mariana, L.

Amphicarpæa, Ell.

comosa (L.), Ridd. (*A. monoica*, Ell.)

pitcheri, Torr. & Gr.; Pitcher.

Apios, Moench.

tuberosa, Moench.

Galactia, P. Browne.

pilosa, Ell.; Torr. & Gr. The plant reported by Butler under the name *G. mollis*, Michx., is probably also of this species, Coville.

Dioclea, HBK.

boykinii, Gray; Leavenworth, Harvey.

Phaseolus, L.*

helvolus, L. This may, perhaps, also include the *P. diversifolius* of Butler and Harvey. A form referred to here as a possible variety was found in a pine barren west of Little Rock by Coville.

pauciflorus, Benth.; Leavenworth, Butler.

Vigna, Savi.

luteola (Jacq.), Benth.; Harvey.

Rhynchosia, Lour.

latifolia, Nutt.

tomentosa (L.), Hook. & Arn.; Lesquereux.

var. erecta (Walt.), Torr. & Gr.

var. volubilis (Michx.), Torr. & Gr.; Coville, Blatchley.

Sophora, L.

affinia, Torr. & Gr.

Gymnocladus, Lam.

dioicus (L.), Koch. (*G. canadensis*, L.) Abundant along Crowley's Ridge.

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*These species are restored to Elliott's genus *Strophostyles* in the Sixth Edition of Gray's Manual.

Gleditschia, L.

inermis, Miller. (*G. monosperma*, Walt.); Harvey.

tracanthos, L. Abundant in rich bottoms.

var. brachycarpus, Michx.; Nuttall.

Cassia, L.

chamæcrista, L.

marilandica, L.

nictitans, L.; d'Ailly, Butler.

occidentalis, L. Abundant as a weed on village commons in the White River valley; Coville.

tora, L.; James; sand-bars, Washington county, Harvey (as *C. obtusifolia*, L).

Cercis, L.

canadensis, L.

Neptunia, Lour.

virgata (Bartr.). (*N. lutea*, Benth.); Nuttall, Leavenworth.

Desmanthus, Willd.

brachylobus (Willd.), Benth.

cooleyi (Eaton), (*D jamesii*, Torr. & Gr.); James.

leptolobus, Torr. & Gr.

Schrankia, Wild.

angustata, Torr. & Gr. At the south end of Main street, Little Rock; Coville.

intsia (Walt.), (*S. uncinata*, Willd).

Acacia, Willd.

filicoides. (Cav.) (*A. filicina*, Willd).

ROSACEÆ.

Prunus, L.

angustifolia, Marsh. (*P. chicasa*, Michx).

americana, Marsh.

caroliniana, Ait.

pumila, L.; Torrey & Gray; Lesquereux.

serotina, Ehrh.

Spiræa, L.

aruncus, L.; Nuttall; Harvey.

tomentosa, L.; Grand Prairie; Harvey.

Neillia, Dow.

opulifolia (L.), Bent. & Hook; Lesquereux, Harvey.

Gillenia, Moench.

stipulata (Muhl.) (*G. stipulacea*, Nutt.)

trifoliata (L.), Moench.; Washington county; Harvey.

Rubus, L.

canadensis, L.

cuneifolius, Pursh; Lesquereux, Harvey.

hispidus, L.; Harvey.

trivialis, Michx.; Torrey & Gray, Lesquereux.

villosus, Ait.

Geum,

album, Gmel.

vernum (Raf.), Torr. & Gr.; Harvey.

Fragaria, L.

indica, Andr.; d'Ailly, Harvey.

virginiana, Duchesne.

Potentilla, L.

canadensis, L.

Agrimonia, L.

eupatoria,

parviflora, Ait.

Poterium, L.

annuum, Nutt.; Nuttall, Leavenworth.

Rosa, L.

blanela, Ait.

var. arkansana (Porter), Best.

carolina, L.; Harvey.

foliolosa, Nutt.; Pitcher, Bigelow, *fide* Watson in Proc. Am. Acad., xx, p. 349; Coville.

humilis, Marsh.; Fendler, *fide* Watson, l. c., p. 348; Coville. The plant that Lesquereux called

R. lucida undoubtedly belongs here, the two species not being separated when his list was made—Coville.

setigera, Michx.; Lesquereux; also Bigelow and Harvey, *fide* Watson, l. c., p. 350; Ehrhart; Blatchley near Bradford by railway.

Pirus, L.

arbutifolia (L.), L. f.

coronaria, L; Harvey; Crowley's Ridge, Call.

Cratægus, L.

æstivalis (Walt.), Torr. & Gray.

apiifolia (Marsh.), Michx.; Harvey, Blatchley.

arborescens, Ell.; Harvey.

coccinea, L.

cordata (Mill.), Ait.; Harvey.

crus-galli, L.

flexispine (Moench.), Sargent. (*C. flava*, Ait.); Lesquereux.

spathulata, Michx.

subvillosa, Schrad.; Letterman, *fide* Harvey.

Some specimens collected in Independence county, at the junction of Power's Creek and the Salado by Coville.

tomentosa, L.

var. punctata (Jacq.), Gray; Lesquereux.

Amelanchier, Linde.

canadensis (L.), Med.

var. obovalis (Michx.), BSP.

(*var. oblongifolia*, Torr. & Gr.)

SAXIFRAGACEÆ.

Heuchera, L.

americana, L.

hallii, Gray; Porter, *fide* Wheelock.

villosa, Michx; Harvey (but out of the range assigned to the species by Wheelock.)

Saxifraga, L.
virginiensis, Michx.; Lesquereux, Coville.
Parnassia, L.
caroliniana, Michx.; Lesquereux, d'Ailly.
Hydrangea, L.
arborescens, L.
Philadelphus, L.
inodorus, L. On a rocky copse, at the south margin of the White River bottom, near Batesville; Coville.
Itea, L.
virginica, L. Along Duparty Creek, Independence county, Coville; Hot Spring county, d'Ailly.
Ribes, L.
aureum, Pursh.; Torrey & Gray.
var. tenuiflorum (Lindl.), Torrey; Torrey & Gray.
floridum, L. Her.; Lesquereux.

CRASSULACEÆ.

Sedum, L.
nevii, Gray. A dead fruiting specimen of a plant answering to the generic description of *Diamorpha*, but certainly not *D. pusilla*, was found in one place in Independence county, in dry limestone soil. It is probably *Sedum nevii*; Coville.
pulchellum, Michx.
ternatum (Haw.), Michx.; Lesquereux.
torreyi, Don.
Penthorum, L,
sedoides, L.

DROSERACEÆ.

Drosera, L.
capillaris, Poir.; d'Ailly.

HAMAMELACEÆ.

Hamamelis, L.

virginica, L.

Liquidambar, L.

styraciflua, L.

HALORAGEÆ.

Proserpinaca, L.

palustris, L.

Myriophyllum, L.

heterophyllum, Michx.

pinnatum (Walt.), BSP. (*M. scabratum*, Michx.); Nuttall, Lesquereux.

spicatum, L.; Nuttall, Lesquereux.

CALLITRICHACEÆ.

Callitriche, L.

autumnalis, L.; Lesquereux.

nuttallii, Torr.; Nuttall.

peploides, Nutt.; Nuttall.

verna, L.; Nuttall, Lesquereux.

MELASTOMACEÆ.

Rhexia, L.

mariana, L.; Russell, Bald Knob, etc., low ground, second bottoms, Blatchley; Texarkana, Harvey.

virginica, L.; Torrey & Gray; Washington county, Harvey.

LYTHRACEÆ.

Ammannia, L.

latifolia, L.

ramosior, L. (*A. humilis*, Michx.); Butler, Harvey.

Peplis, L.

diandra, Nutt. (*Didiplis linearis*, Raf.); Nuttall.

Cuphea, P. Br.

petiolata (L.), Koehne (*C. viscosissima*, Jacq.)

Lythrum, L.

alatum, Pursh.

ONAGRACEÆ,

Epilobium, L.

coloratum, Muhl.; Harvey.

Jussiæa, L.

decurrens (Walt.), DC.

octonervia, Lam.

pilosa, HBK.; Torrey & Gray.

repens, L.

Ludwigia, L.

alternifolia, L.

cylindrica, Ell.; Argenta, Harvey.

hirtella, Raf.; d'Ailly.

palustris (L.), Ell.

polycarpa, Short & Peter; Lesquereux.

Œnothera, L.

biennis, L.

fruticosa, L.

linifolia, Nutt.

rhombipetala, Nutt.; Nuttall, Engelmann.

serrulata, Nutt.; Nuttall, Leavenworth.

sinuata, L.

speciosa, Nutt.

triloba, Nutt.

Gaura, L.

biennis, L.

coccinea, Nutt.; Torrey & Gray.

filipes, Spach.; Torrey & Gray, Lesquereux.

parviflora, Dougl.; Nuttall, James.

sinuata, Nutt.; Nuttall.

villosa, Torr. "Arkansas? Mr. Beyrich." Torrey & Gray, Coville.

Stenosiphon, Spach.

virgatum, Spach.; Nuttall, Lesquereux.

Circæa, L.

lutetiana, L.

LOASACEÆ.

Mentzelia, L.

oligosperma, Nutt.; Torrey & Gray, Nuttall.

PASSIFLORACEÆ.

Passiflora, L.

incarnata, L.

lutea, L.; Newark, Independence county, Blatchley; Washington county, Harvey.

CUCURBITACEÆ.

Melothria, L.

pendula, L.

Trianosperma, Mart.

boykinii (Torr. & Gr.), Roem. (*Bryonia boykinii*, Torr. & Gr.); Arkansas City, Harvey.

Sicyos, L.

angulatus, L.

CACTACEÆ.

Opuntia, Mill.

engelmanni, Salm.; on Crowley's Ridge, Call.

missouriensis, DC.

rafinesquii, Engelm.

FICOIDEÆ.

Mollugo, L.

verticillata, L.

UMBELLIFERÆ.

Hydrocotyle, L.

umbellata, L.

verticillata, Thunb. (*H. interrupta*, Muhl.); d'Ailly.

Eryngium, L.

baldwinii, Spreng.

diffusum, Torr.; James.

leavenworthii, Torr. & Gr.; Leavenworth.
virginianum, Lam.; Lesquereux.
yuccæfolium, Michx.

Sanicula, L.
marilandica, L.
var. canadensis (L.), Torr.; Newark and Black Rock on high grounds, Blatchley.

Eulophus, Nutt.
americanus, Nutt; Nuttall.

Bupleurum, L.
rotundifolium, L.; Harvey.

Leptocaulis, Nutt.
divaricatus, DC.; Nuttall.
echinatus, Nutt.; Nuttall.

Apium, L.
leptophyllum (DC.), F. Muell.; Nuttall.

Apiastrum, Nutt.
patens (Nutt.), C. & R.; Nuttall.

Circuta, L,
virosa, L.,
var. maculata (L.), Coult. & Rose.

Berula, Koch.
angustifolia (L.), Koch.; Lesquereux.

Pimpinella, L.
integerrima (L.), Benth. & Hook. (*Zizia integerrima.*)

Cryptotænia, DC.
canadensis (L.), DC.; Washington county, Harvey.

Osmorrhiza, Raf.
claytoni (Michx.—*O. brevistylis*, DC.); Argenta, Harvey.
longistylis (Torr.), DC.; Butler, Harvey.

Chærophyllum, L.
procumbens (L.), Crantz.
var. shortii, Torr. & Gr.; *fide* Coulter and Rose.
var. tainturieri (Hook.), C. & R.

Cynosciadium, DC.

digitatum, DC.

pinnatum, DC.

Discopleura, DC.

capillacea (Walt.), DC.; Butler.

var. nuttallii (DC.), C. & R.; Prairies, Harvey.

Cymopterus, Raf.

glomeratus, Raf.; Nuttall.

Thaspium, Nutt.*

aureum, Nutt.; Independence county, Coville; Call.

var. trifoliatum (Gray), C. & R.; d'Ailly.

barbinode, Nutt.

Tiedemannia, DC.

rigida (L.), Coult. & Rose, Lesquereux, Harvey (under *Archemora*).

Pastinaca, L.

sativa, L.; Butler.

Polytænia, DC.

nuttallii, DC.; Butler; Grand Prairie, Harvey.

Bifora, Hoffm.

americana (DC.), Benth. & Hook.

Trepocarpus, Nutt.

æthusæ, Nutt.

Daucus, L.

pusillus, Michx.; Torrey & Gray, Harvey.

ARALIACEÆ.

Aralia, L.

quinquefolia (L.), Decsne. & Planch.

spinosa, L.

CORNACEÆ.

Cornus, L.

asperifolia, Michx.; Harvey.

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*Forms with wingless fruit, corresponding in general to the first two of these, and which may occur in Arkansas, are placed under *Zizia*, by Coulter & Rose, N. Am. Umbelliferæ (pp. 82 and 127).

candidissima, Marsh. (*C. stricta*, Lam.); Lesquereux.
florida, L.
sericea, L.; Lesquereux, Harvey.

Nyssa, L.
aquatica, L. (*N. sylvatica*, Marsh.) Fendler, *fide* Coulter & Evans.
(*ogeche*, Marshall (*N. capitata*, Walt.), is said by Coulter & Evans to be large-leaved forms of *N. aquatica*, so far as Arkansas specimens are concerned.)
uniflora, Wang,

CAPRIFOLIACEÆ.

Sambucus, L.
canadensis, L.

Viburnum, L.
dentatum, L.; Lesquereux.
lentago, L.; Harvey.
molle, Michx.; d'Ailly.
nudum, L.
prunifolium, L.

Triosteum, L.
augustifolium, L.; Nuttall, Harvey.
perfoliatum, L.; Lesquereux, Harvey.

Symphoricarpus, Juss.
vulgaris, Michx.

Lonicera, L.
albiflora, Torr & Gr.; Lesquereux.
flava, Sims.; Butler. There is considerable doubt as to the authenticity of Butler's plant.—Coville.
glauca, Hill; Harvey, as *L. parviflora*, Lam. This, like the preceding, is doubtful.
sempervirens, L.

RUBIACEÆ.

Cephalanthus, L.
occidentalis, L.

Oldenlandia, L.

boscii (DC.), Chapm.; Gray, Harvey.

uniflora, L. (*O. glomerata*, Michx.); Butler.

Houstonia, L.

angustifolia, Michx.

cærulea, L.

minima, Beck.; Nuttall.

patens, Ell.; Harvey.

purpurea, L.

var. calycosa (Shuttlew), Gray; Nuttall.

var. longifolia (Gærtn.), Gray.

Mitchella, L.

repens, L.

Diodia, L.

teres, Walt.

virginiana, L.

Spermacoce, L.

glabra, Michx. (probably *S. tenuior*, L. *fide* Gray).

Galium, L.

aparine, L.; Butler.

arkansanum, Gray.

circæzans, Michx.; Nuttall, Harvey.

concinnum, Torr. & Gr.; Gray.

latifolium, Michx.; Lesquereux; Bradford, in low ground, Blatchley.

pilosum, Ait.

trifidum, L.

triflorum, Michx.

virgatum, Nutt.

VALERIANACEÆ.

Valerianella, Tourn.

longiflora (T. & Gr.), Walp.; Harvey, Engelmann.

nuttallii (T. & Gr.), Walp.; Nuttall, Engelmann.

radiata, Dufr.; Butler, Harvey.

COMPOSITÆ.

Vernonia, Schreb.

arkansana, DC.

baldwinii, Torr.

fasciculata, Michx.; Lesquereux, d'Ailly.

gigantea (Walt.), (*V. altissima*, Nutt.) Torr & Gray; Harvey.

granienifolia (Walt.), (*V. angustifolia*, Michx.)

var. texana (Gray); Coville.

lettermani, Englm.

marginata (Torr.) (*V. jamesii*, Torr. & Gr.; Nuttall).

noveboracensis (L.), Willd.

Elephantopus, L.

carolinianus, Willd.

nudatus, Gray; Harvey.

tomentosus, L.; Nuttall, d'Ailly.

Eupatorium, L.

ageratoides, L. f.

album, L.; d'Ailly, Harvey.

altissimum, L.

cœlestinum, L.

hyssopifolium, L.; Lesquereux.

perfoliatum, L. Leaves in threes, Blatchley.

pupureum, L. Near Coffeeville, Blatchley; southern part of the state, Harvey.

rotundifolium, L.

var. pubescens (Muhl.; *var. ovatum*, Torr.); d'Ailly.

semiserratum, DC.; Gray.

serotinum, Michx.

sessilifolium, L.; Harvey.

Kuhnia, L.

eupatorioides, L.; Lesquereux, Harvey.

Liatris.

cylindracea, Michx.; Lesquereux.

elegans, Willd.; Lesquereux, d'Ailly.
punctata, Hook; Nuttall.
pycnostachya, Michx.; Torr. & Gr.
scariosa (L.), Willd.
spicata (L.), Willd.
squarrosa (L.), Willd.

Gutierrezia, Lag.
sphærocephala, Gray.
texana (DC.), Torr. & Gr.; Nuttall.

Amphiachyris, Nutt.
dracunculoides, Nutt.; Nuttall.

Grindelia, Willd.; Nuttall.
inuloides, Willd.; Nuttall.
lanceolata, Nutt.

Heterotheca, Cass.
subaxillaris. (Lam.); (*H. lamarckii*, Cass.)

Chrysopsis, Nutt.
graminifolia (Michx.); Nutt.; d'Ailly; Hot Springs, Harvey.
pilosa, Nutt.
villosa, Nutt.; Butler.
var. stenophylla, Gray, Bigelow.

Aplopappus, Cass.
divaricatus (Nutt.); Gray.

Solidago, L.
bicolor, L.; Lesquereux, Harvey.
boottii, Hook.; Lesquereux.
cæsia, L.; Lesquereux, Harvey.
canadensis, L.; Lesquereux, Harvey.
caroliniana (L.); BSP. (*S. tenuifolia*, Pursh.); Lesquereux.
corymbosa, Ell.; Lesquereux.
drummondii, Torr. & Gr.; Lesquereux.
lanceolata, L.; Lesquereux, Harvey.
leptocephala, T. & Gr.; Harvey.

missouriensis, Nutt.; Nuttall.
nemoralis, Ait.; Lesquereux, Harvey.
odora, Ait.; Lesquereux, d'Ailly.
petiolaris, Ait.; Lesquereux, Harvey.
var. angusta (T. & Gr.), Gray; Nuttall.
pilosa, Walt.; Lesquereux.
puberula, Nutt.; Butler. Not given by Gray so far west, Coville.
radula, Nutt.; Lesquereux.
rigida, L.; Lesquereux, Harvey.
rugosa, Mill.; Lesquereux, d'Ailly.
serotina, Ait; Lesquereux, Harvey.
shortii, Torr. & Gr.; Harvey.
speciosa, Nutt.; Lesquereux, Harvey.
ulmifolia, Muhl.

Aphanostephus, DC.
skirrobasis (DC.; *A. arkansana*); Nuttall.

Bellis, Tourn.
integrifolia, Michx.

Chætopappa, DC.
asteroides, DC.

Boltonia, L'Her.
diffusa, Ell.; Harvey.

Sericocarpus, Nees.
linifolius (L.), BSP. (*S. solidagineus*, Nees.); Lesquereux.

Aster, L.
anomalus, Engelm.; Gray, Harvdy.
azureas, Lindl.; Lesquereux, Harvey.
concinnus, Willd.; Harvey.
cordifolius, L.; Lesquereux, d'Ailly.
diffusus, Ait.; Harvey.
drummondii, Lindl.; d'Ailly, Harvey.
dumosus, L.
var. subulæfolius, T. & Gr.

exilis, Ell.; Nuttall.
lævis, L.; Lesquereux.
linariifolius, L; Lesquereux, Harvey (as *Diplopappus*).
multiflorus, Ait.; Lesquereux, Harvey.
novæ-angliæ, L.; d'Ailly, Harvey.
oblongifolius, Nutt.
paniculatus, Lam. The plant called by Lesquereux *A. tenuifolius*, L. probably belongs here, but it may be *A. ericoides*, L.—Coville. The *A. carneus*, Nees, of Harvey probably also goes here.
patens, Ait.
ptarmicoides, T. & Gr.
var. georgianus, Gray; Harvey.
puniceus, L.; Lesquereux.
saggittifolius, Willd.; Lesquereux.
sericeus, Vent.; Lesquereux.
turbinellus Lindl.; Lesquereux, Harvey.
umbellatus, Mill.; southern part of state, Harvey; this is probably also the *A. amygdalinus* of Nuttall.
undulatus, L.; Lesquereux.
vimineus, Lam.; Gray. The *A. miser*, L., reported by Butler, probably goes here.
virgatus, Ell.; Harvey.

Erigeron, L.
annuus (L.), Pers.; Lesquereux, Harvey.
bellidifolius, Muhl.; Harvey.
canadensis, L.
divaricatus, Michx.
divergens, Torr. & Gr.
var. cinerius, Gray; Gray.
philadelphicus, L.; Butler, Harvey.
ramosus (Walt.), BSP. (*E. strigosus*, Muhl.)
var. beyrichii (Fish. & Mey.); Gray.

Baccharis, L.
salicina, Torr. & Gr; Nuttall.
Pluchea, Cass.
camphorata (L.), DC; Lesquereux, Harvey.
Evax, Gærtn.
prolifera, Nutt.; Nuttall.
Antennaria, Gærtn.
plantiginifolia (L.), Hook; Butler, Harvey.
Gnaphalium, L.
decurrens, Ives; Lesquereux.
obtusifolium, L. (*G. polycephalum*, Michx.); Lesquereux, Harvey.
purpureum, L.; Gray.
mightii, Gray.; Gray, d'Ailly.
Polymnia, L.
canadensis, L.; Lesquereux.
var. radiata, Gray; Harvey, Coville.
uvedalia, L.
Melampodium, L.
cinereum, DC.; Gray.
Silphium, L.
asperrimum, Hook.; Gray.
asteriscus, L; Harvey.
integrifolium, Michx.
laciniatum, L.; Lesquereux, Harvey.
perfoliatum, L.; Washington county, Harvey.
scaberrimum, Ell.; Lesquereux.
terebinthinaceum, Jacq.; Lesquereux, Harvey.
trifoliatum, L.; Lesquereux.
Berlandiera, DC.
lyrata, Benth.; Gray.
pumila (Michx.). (*B. tomentosa*, Nutt.); Lesquereux.
var. dealbata (Torr. & Gr.); Gray.
texana, DC.; Nuttall.

Engelmannia, Torr. & Gr.

pinnatifida, T. & Gr.; Lesquereux.

Parthenium, L.

hysterophorus, L. Embankment of the Iron Mountain railway, in the City of Little Rock. Introduced from farther west.—Coville.

integrifolium, L.; Lesquereux. Eastern part of the state, Harvey.

Iva, L.

augustifolia, Nutt.; Nuttall.

ciliata, Willd.; Nuttall.

Ambrosia, L.

artemisiæfolia, L.

bidentata, Michx.

psilostachya, DC.; Lesquereux.

trifida, L.

Xanthium, L.

strumarium, L.; Lesquereux, Harvey.

Zinnia, L.

pauciflora, L.; Lesquereux.

Heliopsis, Pers

gracilis, Nutt.; Gray.

helianthoides (L.), BSP. (*H. lævis*, Pers.); Lesquereux.

scabra, Dunal.

Eclipta, L.

alba (L.) Hassk; d'Ailly.

Echinacea, Moench.

augustifolia, DC.

purpurea (L.), Moench.

Rudbeckia, L.

alismæfolia, Torr. & Gr.; Gray, Harvey.

amplexicaulis, Vahl.; Nuttall.

atrorubens, Nutt.; Nuttall.

bicolor, Nutt.; Nuttall.

fulgida, Ait.; Lesquereux, Harvey.

grandiflora, Gmel.; Nuttal.
hirta, L.
laciniata, L.
maxima, Nutt.; Nuttall.
speciosa, Wender.; Gray.
subtomentosa, Pursh.
triloba, L.; Lesquereux Harvey.

Lepachys, Raf.
pinnata (Vent.), T. & Gr.; Harvey.
tagetes, Gray ; Gray.

(*Tetragonotheca*, Dill.
helianthoides, L. Lesquereux was probably mistaken in this plant. It is impossible to say what the species that he places here really was. —Coville).

Helianthus, L.
augustifolius, L.; Harvey.
annuus, L.; Nuttall.
atrorubens, L.; Nuttall.
diffusus, Sims. (*H. rigidus*, Deasf.); Lesquereux, Harvey.
grosse-serratus, Martens; Nuttall.
hirsutus, Raf.
var. trachyphyllus, Torr. & Gr.; Gray, Harvey.
(*lætiflorus*, Pers. Lesquereux was probably mistaken in his determination of this plant.—Coville.)
mollis, Lam.; Lesquereux, Harvey.
occidentalis, Ridd.
orgylas, DC.; Nuttall.
parviflorus, Bernh.; Harvey, as *H. microcephalus*, T. & Gr.
petiolaris, Nutt.; Nuttall.
strumosus, L.; Gray.
tracheliifolius, Willd; Boston Mountains, Harvey.
tuberosus, L.; Gray.

Spilanthes, Jacq.
repens (Walt.), Michx.
Actinomeris, Nutt.
alternifolia (L.), DC. (*A. squarrosa*, Nutt.)
Verbesina, L.; emend.
helianthoides, Michx.; Lesquereux, d'Ailly, Harvey.
virginica, L.
Coreopsis, L.
aristosa, Michx; Butler, Harv y.
auriculata, L.; Harvey.
discoidea, Torr & Gr.; Butler.
grandiflora, Nutt.
harveyana, Gray, Harvey, Coville.
involucrata, Nutt.; Nuttall.
lanceolata, L.; Lesquereux, Harvey.
palmata, Nutt.
tinctoria, Nutt.; Nuttall.
tripteris, L.; Harvey.
verticillata, L.; Lesquereux. Near Bald Knob and Bradford.—Blatchley.
Thelesperma, Less.
filifolium, Gray; Gray.
Bidens, L.
bipinnata, L.
cernua, L.; Lesquereux.
chrysanthemoides, Michx.; Lesquereux, Harvey.
frondosa, L.; Harvey.
Marshallia, Schreb.
cæspitosa, Nutt.; Nuttall.
trinervia (Walt.), (*M. latifolia*, Pursh.); Lesquereux. Not credited to Arkansas by Gray.
Homenopappus, L'Her.
corymbosus, Torr. & Gr.; Nuttall.
tenuifolius, Pursh; Gray.

Polypteris, Nutt.

callosa (Nutt.), Gray; Lesquereux.

sphacelata (Nutt.), (*P. hookeriana*, Gray); Nuttall.

Dysodia, Cav.

chrysanthemoides, Lag.

Hymenatherum, Cass.

tagetoides (T. & Gr.) Gray; Nuttall.

Helenium, L.

autumnale, L.

nudiflorum, Nutt.; Lesquereux; Harvey (as *Leptopoda brachypoda*.)

quadridentatum, Labill.; Nuttall.

tenuifolium, Nutt.

Gaillardia, Foug.

lanceolata, Michx.; Nuttall.

pinnatifida, Torr.; Nuttall.

pulchella, Foug.; Nuttall.

Achillea, L.

millefolium, L.

Anthemis, L.

cotula, L.

Artemesia, L.

lewisii, Torr. & Gr. Probably a fictitious species according to Gray, Syn. Fl., II, 417, the Arkansas specimen of Engelmann, probably *A canadensis*, but immature.

mexicana, Willd.; Gray.

Erechtites, Raf.

hieracifolia (L.), Raf.; Lesquereux.

Senecio, L.

aureus, L.

var. obovatus (Muhl.) Torr. & Gr; Harvey.

lobatus, Pers.; d'Ailly.

tomentosus, Michx.; Gray, d'Ailly.

Cacalia, L.

atriplicifolia, L.

tuberosa, Nutt.; Lesquereux; Blatchley at Bradford. Neither species of *Cacalia* is credited by Gray to Arkansas—Coville.

Arctium, L.

lappa, L. (*Lappa officinalis*, All.)

Cnicus, L.

altissimus (L.), Willd.

var. discolor (Muhl.), Gray; Lesquereux.

lanceolatus (L.), Hoffm.; Harvey.

virginianus (L.), Pursh; Lesquereux.

Centaurea, L.

americana, Nutt.; Nuttall.

Cichorium, L.

intybus, L.; Harvey.

Krigia, Schreb.

amplexicaulis (Michx.), Nutt.; Harvey.

dandelion (L.), Nutt.; Nuttall, Harvey.

occidentalis, Nutt.; Nuttall.

virginica (L.). Willd; Harvey.

Apogon, Ell.

humilis, Ell.; Nuttall.

var. lyrata (Nutt.); Harvey.

wrightii, Gray. Collected by G. W. Letterman at Prescott, Ark.; in Harvey herbarium at Arkansas Industrial University.

Hieracium, L.

gronovii, L.; Nuttall.

longipilum, Torr.

scabrum, Michx.; Lesquereux.

venosum, L.; Hot Springs, Harvey.

Taraxacum, Hall.

officinale, Web.; Lesquereux.

Pyrrhopappus, DC.

carolinianus (Walt.), DC. At Bradford by the railway—Blatchley.

Lactuca, L.

elongata, Muhl.; Lesquereux. The old *L. elongata*, Muhl., has been broken up into several species: *L. canadensis*, *L.*, *L. integrifolia*, Bigel., *L. hirsuta*, Muhl., and *L. graminifolia*, Michx. Probably all occur in the state—Coville. L. *sanguinea* (*L. hirsuta*) occurs at Newark, on high dry ground—Blatchley.

floridana (L.), Gærtn.; Lesquereux, Harvey.

Prenanthes, L.

alba, L.; Lesquereux.

altissima, L; Lesquereux, Harvey.

aspera, Michx.

autumnalis, Walt. (*P. virgata*, Michx); Lesquereux.

Sonchus, L.

asper, Vill.; Harvey; Walnut Ridge, Blatchley.

LOBELIACEÆ.

Lobelia, L.

appendiculata, A. DC.; Gray, Harvey.

brevifolia, Nutt.; Engelmann, *fide* Butler.

cardinalis, L.

inflata, L.

leptostachys, A. DC. In dry woods.

puberula, Michx., Butler, Harvey.

spicata, Lam.; Lesquereux, Harvey.

syphilitica, L.

CAMPANULACEÆ.

Campanula, L.

americana, L.

Specularia, Heist.

biflora (Ruiz & Pavon), Gray; Gray.

leptocarpa (Nutt.), Gray; Gray, Harvey.

perfoliata (L.) A. DC.

VACCINIACEÆ.

Gaylussacia, HBK.

frondosa (L.), Torr. & Gr.; Lesquereux.

resinosa (Ait.) Torr. & Gr.; Lesquereux.

Vaccinium, L.

arboreum, Marsh.

corymbosum, L; Lesquereux, d'Ailly.

var. fuscatum (Ait.), Gray; Gray.

stamineum, L.

virgatum, Ait.

var. parviflorum, Gray; Gray.

var. tenellum (Ait.) Gray; Gray.

ERICACEÆ.

Gaultheria, L.

procumbens, L.; Lesquereux.

Leucothoe, Don.

axillaris (Lam.), Don.; Lesquereux. Not credited to Arkansas by Gray—Coville.

Oxydendrum, DC.

arboreum (L.), DC.; Lesquereux. Not credited to Arkansas by Gray—Coville.

Epigæa, L.

repens, L; Lesquereux.

Andromeda, L.

ligustrina, Muhl. Between Batesville and Jamestown, Independence county, Coville; central part of the state, Harvey.

mariana, L; Gray; central part of the state, Harvey.

Kalmia, L.

latifolia, L.; Lesquereux.

Rhododendron, L.

(*maximum*, L.; Lesquereux. The leaves only of this were seen by Lesquereux, and the identification is probably incorrect—Coville.)

nudiflorum (L.), Torrey.
viscosum (L.), Torrey; Lesquereux, d'Ailly.
Chimaphila, Pursh.
maculata (L.), Pursh; Lesquereux.

MONOTROPEÆ.

Monotropa, L.
uniflora, L.; Harvey, Simonds.

PRIMULACEÆ.

Hottonia, L.
inflata, Ell.; Butler, d'Ailly.
Androsace, L.
occidentalis, Pursh; Harvey.
Dodecatheon, L.
media, L.; Lesquereux.
var. brevifolium, Gray. A form closely resembling the true *var. brevifolium* Gray of California; Coville
Steironema, Raf.
ciliatum (L.), Raf.; Lesquereux; southern part of the state, Harvey.
lanceolatum (Walt.), Gray.
radicans (Hook.), Gray. In a swamp at the south end of Main street, Little Rock, Coville.
Anagallis, L.
arvensis, L.; Harvey.
Centunculus, L.
minimus, L.; Nuttall.
Samolus, L.
ebracteatus, HBK.; Gray.
valerandi, L.
var. floribundus (HBK.), BSP. var. *americanus*, Gray.

SAPOTACEÆ.

Bumelia, Sw.
lycioides (L.), Pers.; Nuttall.
lanuginosa (Michx.), Pers.

EBENACEÆ.

Diospyros, L.

virginiana, L.

STYRACEÆ.

Symplocos, L.

tinctoria, (L.), L'Her.

Halesia, Ellis.

diptera, L.; Hot Springs, Harvey.

tetraptera, L.; Butler. Neither species is credited to Arkansas by Gray—Coville.

Styrax, Tourn.

americana, Lam.; Gray. *S. grandiflora*, Ait., reported by Nuttall, probably goes here—Coville.

pulverulenta, Michx.; Little Rock, Harvey.

OLEACEÆ.

Fraxinus, L.

americana, L.

platycarpa, Michx.; Harvey.

quadrangulata, Michx.; Nuttall.

sambucifolia, Lam.

viridis, Michx.; f.

Forestiera, Poir.

acuminata (Michx.), Poir.

pubescens, Nutt.; Nuttall.

Chionanthus, L.

virginica, L; Harvey, Coville.

Osmanthus, Lour.

(*americanus* (L.), B & H. Nuttall was probably mistaken in reporting this plant from Arkansas—Coville.)

APOCYNACEÆ.

Amsonia, Walt.

ciliata, Walt. (*A. angustifolia*, Michx.) Hot Springs, Letterman; Harvey's herbarium.

tabernæmontana, Walt.; Harvey, Coville.

Apocynum, L.
androsæmifolium, L.; Harvey.
cannabinum, L.; Lesquereux.
Trachelospermum, Lem.
difforme, (Walt.) Gray; Butler, Harvey.

ASCLEPIADACEÆ.

Acerates, Ell.
longifolia, (Michx.) Ell.
viridiflora, (Raf.) Ell.
Asclepias, L.
incarnata, L.; Washington county, Harvey.
lanceolata, Walt. (*A. paupercula*, Michx.); Lesquereux.
obtusifolia, Michx.; Harvey.
perennis, Walt.
purpurascens, L.; Harvey.
quadrifolia, L.
speciosa, Torr.; Gray.
stenophylla, Gray; Gray.
tuberosa, L.
variegata, L.
verticillata, L.
Asclepiodora, Gray.
decumbens (Nutt.), Gray; Gray.
viridis (Walt.), Gray; Nuttall.
Enslenia, Nutt.
albida, Nutt.; Lesquereux.
Gonolobus, Michx.
baldwinianus, Sweet; Engelmann, Harvey.
biflorus, Nutt.; Nuttall.
carolinensis (Jacq.), R. Br.; Gray.
cynanchoides, Engelm.; Gray.
lævis, Michx.,
var. macrophyllus (Michx.), Gray; Lesquereux.

LOGANIACEÆ.

Gelsemium, Juss.
sempervirens (L.), Ait.; Lesquereux, d'Ailly.

Spigelia, L.
marilandica, L.

Mitreola, L.
petiolata (Walt.), Torr. & Gr; Harvey; Hot Springs, Letterman

Polypremum, L.
procumbens, L.

GENTIANACEÆ.

Erythræa, Rich.
beyrichii, Torr. & Gr.; Beyrich, Marcy.

Sabbatia, Adans.
angularis (L.), Pursh.
campestris, Nutt.; Nuttall,
dichotoma (Walt.), (*S. calycosa*, Pursh); Harvey.

Gentiana, L.
andrewsii, Griseb.; Lesquereux.
puberula, Michx.; Lesquereux, Harvey.
saponaria, L.
villosa, L. (*G. ochroleuca*, Froel.); Lesquereux.

Frasera, Walt.
carolinensis, Walt.; d'Ailly.

Limnanthemum, Gmel.
lacunosum (Vent.), Griseb.; Lesquereux.

POLEMONIACEÆ.

Phlox, L.
amœna, Sims.; Harvey.
divaricata, L.; Gray, Harvey.
glaberrima, L.
maculata, L.
paniculata, L.
pilosa, L.
reptans, Michx.; Nuttall.

Gilia, Ruiz & Pav.

coronopifolia, Pers.; Nuttall.

Polemonium, L.

reptans, L.

HYDROPHYLLACEÆ.

Hydrophyllum, L.

virginianum, L.

Nemophila, Nutt.

microcalyx (Nutt.), Fisch. & Mey.; Nuttall.

Ellisia, L.

nyctelea, L.

Phacelia, Juss.

glabra, Nutt.; Nuttall.

dubia (L.), (*P. parviflora*, Pursh); Harvey.

var. hirsuta (Nutt.); Lesquereux, Harvey.

patuliflora (Engelm. & Gr.), Gray; Harvey; at Prescott, Letterman.

purshii, Buckl.; Lesquereux.

Hydrolea, L.

affinis, Gray. Southwestern part of the state, Harvey.

ovata, Nutt.

BORRAGINACEÆ.

Heliotropium, L.

convolvulaceum (Nutt.), Gray.

curassavicum, L.; Coville.

indicum, L.

tenellum (Nutt.), Torr.; Nuttall.

Cynoglossum, L,

officinale, L.

viginicum, L.

Echinospermum, Sev.

lappula (L.), Lehm.; Lesquereux, Call.

virginianum (L.), Lehm.

Mertensia, Roth.

virginianum (L.), DC.; Lesquereux.

Myosotis, L.
virginica (L.) BSP. (*M. verna*, Nutt.)
Onosmodium, Michx.
carolinianum (Lam.), DC.; Butler, Harvey.
virginianum (L.), DC.; Lesquereux, Harvey.
Lithospermum, L.
angustifolium, Michx.; Nuttall, Butler.
arvense, L.
canescens (Michx.), Lehm.
carolinense (Gmel.), Lehm. (*L. hirtum*, Lehm.)

CONVOLVULACEÆ.

Ipomœa, L.
hederacea (L.), Jacq.; Harvey.
lacunosa, L.
pandurata (L.), Meyer; Harvey.
purpurea (L.), Lam. All the species of *Ipomœa* were reported by Nuttall, according to Lesquereux, Coville.
Jacquemontia, Choisy.
tamnifolia (L.), Griseb.
Convolvulus, L.
arvensis, L.
incanus, Vahl.; Nuttall.
Evolvulus, L.
argenteus, Pursh; Nuttall.
Dichondra, Forst.
repens, Forst.; Nuttall.
Cuscuta, L.
arvensis, Beyrich; Harvey.
compacta, Juss.; Harvey; Hot Springs, Letterman.
coryli, Engelm. (*C. inflexa*, Engelm.); Butler.
glomerata, Choisy; Lesquereux, Call.
gronovii, Willd.; Nuttall,
polygonorum, Engelm. (*C. chlorocarpa*, Engelm.); Gray, Harvey.

SOLANACEÆ.

Solanum, L.

carolinense, L.

nigrum, L.

rostratum, Dun. This has been noted only along railways.

Physalis, L.

æquata, Jacq., f.; Harvey.

angulata, L.; Walnut Ridge, Blatchley.

lanceolata, Michx.

var. longifolia (Nutt.; *var lævigata*, Gray); Nuttall.

mollis, Nutt.; Nuttall, Harvey.

obscura, Michx.; Harvey.

philadelphica, Lam.; Lesquereux.

pubescens, L.; Coville.

virginiana, Mill. (*P. viscosa*, Gray, not L.); Lesquereux.

Datura, L.

stramonium, L.

tatula, L.; Harvey.

SCROPHULARIACEÆ.

Verbascum, L.

blattaria, L.

thapsus, L.

Linaria, Juss.

canadensis (L.), Dumont.

Scrophularia, L.

nodosa, L.

var. marilandica (L.), Gray.

Chelone, L.

glabra, L.; Lesquereux.

Pentstemon, Mitch.

cobæa, Nutt.; Nuttall.

hirsutus (L.), Willd. (*P. pubescens*, Sol.)

lævigatus, Sol.
var. digitalis (Nutt.), Gray.
tubiflorus, Nutt.
Collinsia, Nutt.
verna, Nutt.; Butler.
violacea, Nutt.; Nuttall, Pitcher.
Mimulus, L.
alatus, Soland.
Conobea, Aubl.
multifida (Michx.), Benth.
Herpestis, Gærtn., f.
acuminata (Walt.) (*H. nigrescens*, Benth.)
monniera (L.), HBK.; Nuttall.
rotundifolia (Michx.), Pursh; Lesquereux, Harvey.
Gratiola, L.
drummondii, Benth.; Gray.
pilosa, Michx.
pusilla, Torr.; Gray.
sphærocarpa, Ell.; Butler, Harvey.
virginiana, L.
Ilysanthes, Raf.
gratioloides (L.), Benth.
Veronica, L.
americana, Schwein.; Lesquereux.
peregrina, L.
virginica, L.
Buchnera, L.
americana, L.
Seymeria, Pursh.
macrophylla, Nutt.
Gerardia, L.
aspera, Dougl.; Lesquereux, Gray.
auriculata, Michx.
flava, L.; Lesquereux.
grandiflora, Benth.; Washington county, Harvey.

heterophylla, Nutt.; Nuttall, Harvey.
lævigata, Raf.; Lesquereux.
pedicularia, L.; Nuttall, d'Ailly.
var. pectinata, Nutt.; Gray, Harvey.
purpurea, L.
var. fasciculata (Ell.), Chapm.; Gray.
setacea, Walt. *var. longifolia* (Nutt.), Gray; Nuttall.
tenuifolia, Vahl.; Butler, Harvey.
var. macrophylla, Benth.; Harvey.
virginica (L.), BSP.? (*G. quercifolia*, Pursh.)

Castilleia, L.; f.
coccinea (L.), Spreng.; Lesquereux, Harvey.
purpurea (Nutt.) Don.; Nuttall.

Pedicularis, L.
canadensis, L.

Melampyrum, L.
lineare, Lam. (*M. americanum*, Michx.); Nuttall.

OROBANCHACEÆ.

Aphyllon, Mitch.
uniflorum (L.), Gray.

LENTIBULARIACEÆ.

Utricularia, L.
vulgaris, L.; Nuttall.

BIGNONIACEÆ.

Bignonia, Tourn.
capreolata, L.; Lesquereux, Coville.

Catalpa, Juss.
(*bignonioides*, Walt. Reported by Lesquereux as apparently indigenous in the extreme north-western part of the state, in Benton county. Professor Harvey supposes, with good reason, that this is *C. speciosa*, which was not specifically separated from *C. bignonioides* at the time of Lesquereux's trip—Coville.)

speciosa, Warder. Reported by Professor Harvey as spontaneous (but probably naturalized) about the town of Washington—Coville.

Tecoma, Juss.

radicans (L.), Juss.

PEDALIACEÆ.

Martynia, L.

proboscidea, Glox. Head of Oil Trough bottoms, low ground near river, Blatchley.

ACANTHACEÆ.

Ruellia, L.

ciliosa, Pursh. *var. humilis* (Nutt.), (*var. longifolia*, Gray); Nuttall.

pedunculata, Torr.

strepens, L.

Dianthera, L.

americana, L.

ovata (Walt.), (*D. humilis*, Engelm. & Gr.); Harvey.

Dicliptera, Juss.

brachiata, Spreng.

var. attenuata, Gray; Nuttall.

VERBENACEÆ.

Phryma, L.

leptostachya, L.

Lippia, L.

lanceolata, Michx.

nodiflora (L.), Michx. Waste places about Little Rock, Coville.

Verbena, L.

angustifolia, Michx. (V. *rugosa*, Willd.; Nuttall.)

aubletia, L.

bipinnatifida, Nutt.; Gray, Harvey.

bracteosa, Michx.

hastata, L.

stricta, Vent.
urticæfolia, L.
Callicarpa, L.
americana, L.

LABIATÆ.

Mentha, L.
canadensis, L.
piperita, L.; Harvey.
viridis, L.; Lesquereux, Blatchley.
Lycopus, L.
rubellus, Mœnch.; Gray, Harvey.
sinuatus, Ell.
virginicus, L.; Nuttall, d'Ailly.
Cunila, L.
mariana, L.
Pycnanthemum, Michx.
albescens, Torr. & Gr.; Harvey.
clinopodioides, Gray; Lesquereux. Far out of range and doubtful—Coville.
flexuosum (Walt.), BSP. (*P. linifolium*, Pursh.)
incanum (L.), Michx.
muticum (Michx.), Pers.
var. pilosum (Nutt.), Gray.
virginicum (L. Pers.); (*P. lanceolatum*, Pursh); Lesquereux.
Origanum, L.
vulgare, L.; Nuttall, d'Ailly.
Hedeoma, Pers.
acinoides, Scheele; Leavenworth.
hispida, Pursh; Gray.
pulegioides (L.), Pers.
Calamintha, Mœnch.
clinopodium, Benth.; Nuttall.
nepeta (L.), Link.; Gray.
glabra (Nutt.) (C. *nuttallii*, Benth.); Nuttall.

Melissa, L.

officinalis, L.

Salvia, L.

azurea, Lam.

var. longifolia (Nutt.), (var. *grandiflora*, Benth).; Nuttall, Harvey.

lyrata, L.

verbenacea, L.; Nuttall.

Monarda, L.

bradburiana, Beck.; Lesquereux, Harvey.

citriodora, Cerv.

fistulosa, L.

var. mollis (L.), Benth.; Harvey.

punctata, L.

russelliana, Nutt.; Nuttall, Harvey.

Blephilia, Raf.

ciliata (L.), Raf.

Lophanthus, Benth.

nepetoides (L.), Benth.

scrophulariæfolius (Willd.), Benth; Nuttall.

Nepeta, L.

cataria, L.

hederacea (L.), BSP.; Lesquereux, Harvey.

Scutellaria, L.

canescens, Nutt.

cardiophylla, Engelm. &. Gr.; Gray; Hot Springs, Harvey.

integrifolia, L.; d'Ailly, Harvey.

lateriflora, L.

nervosa, Pursh; Lesquereux.

parvula, Michx.

resinosa, Torr.; Lesquereux; Newark, Blatchley.

versicolor, Nutt.

Brunella, L.

vulgaris, L.

Physostegia, Benth.

intermedia (Nutt.), Gray; Gray.

virginiana (L.), Benth.; Lesquereux, Harvey.

Marrubium, L.

vulgare, L.; Nuttall, Harvey.

Stachys, L.

aspera, Michx.; Harvey, Coville.

hyssopifolia, Michx.; Nuttall.

Leonurus, L.

cardiaca, L.; Butler.

Lamium, L.

amplexicaule, L.; Nuttall. Cultivated ground, Harvey.

Trichostema, L.

dichotomum, L.; Lesquereux.

lineare, Nutt.; Nuttall.

Isanthus, Michx.

brachiatus (L.), BSP. (*I. cæruleus*, Michx.); Lesquereux, Harvey.

Teucrium, L.

canadense, L.

PLANTAGINACEÆ.

Plantago, L.

elongata, Pursh. (*P. pusilla*, Nutt.)

heterophylla, Nutt.; Nuttall.

lanceolata, L.; d'Ailly.

major, L.; Nuttall, Lesquereux.

patagonica, Jacq. Abundant at Gainesville and Forrest City—Call.

var. aristata (Michnx.), Gray; Nuttall, Harvey.

var. gnaphialoides (Nutt.), Gray; Nuttall, Butler.

var. spinulosa (Decsne.), Gray; d'Ailly.

rugelii; Decsne.; Harvey.

sparsiflora, Michx.; Harvey.

virginica, L.

var. longifolia, Gray; Nuttall; Walnut Ridge, Blatchley.

NYCTAGINACEÆ.

Oxybaphus, Vahl.

albidus (Walt.), Sweet; Lesquereux, Harvey.

angustifolius, Sweet; Nuttall.

nyctagineus (Michx.), Sweet; Nuttall.

ILLECEBRACEÆ.

Paronychia, Tourn.

dichotoma (L.). Nutt.

AMARANTACEÆ.

Amarantus, L.

albus, L.; Nuttall, Coville.

chlorostachys, Willd.; Butler.

hybridus, L.

spinosus, L.

Acnida, L.

tuberculata, Moq. (*A. tamariscina.*); Nuttall, Coville.

Cladothrix, Nutt.

lanuginosa, Nutt.; Nuttall.

Alternanthera, Forsk.

achyrantha (L.), R. Br.; Nuttall.

Frœlichia, Mœnch.

floridana (Nutt.), Moq.; Nuttall, Coville.

Iresine, L.

celosioides, L.

CHENOPODIACEAÆ.

Cycloloma, Moq.

platyphyllum (Michx.), Moq.

Chenopodium, L.

album, L.; Lesquereux, Harvey.

ambrosioides, L. The *var. anthelminticum* differs from the species by such inconstant characters that I could not be sure under which form my own specimens belong—Coville.

boscianum, Moq.; Harvey.
hybridum, L.; Nuttall.
murale, L. Little Rock, along the Iron Mountain railway—Coville.

Atriplex, L.
(*hortensis*, L. Reported by Nuttall as introduced, but apparently not naturalized, and therefore to be excluded from the list proper—Coville.)

Corispermum, L.
hyssopifolium, L.; Nuttall.

PHYTOLACCACEÆ.

Rivina, L.
lævis, L.; Nuttall.

Phytolacca, L.
decandra, L.

POLYGONACEÆ.

Eriogonum, L.
annum, Nutt.; Nuttall.
longifolium, Nutt.

Polygonella, Michx.
ericoides, Gray. Garland county, Letterman; in Harvey herbarium, Arkansas Industrial University—Simonds.

Polygonum, L.
acre, HBK.; Harvey.
amphibium, L; Lesquereux. This species has been divided since Lesquereux's list came out, and his specimens may not belong to the true *P. amphibium*—Coville.
articulatum, L.; Nuttall.
aviculare, L.
convolvulus, L.; Nuttall.
dumetorum, L; Lesquereux, Harvey.
    var. scandens (L.), Gray; Harvey.
erectum, L.; Nuttall, Harvey.

hirsutum, Walt.; Nuttall.
hydropiperoides, Michx.
incarnatum, Ell.; Butler, Harvey.
meisnerianum, Cham. & Schl. Gravelly bank of White River near a ford, about one mile above Batesville—Coville.
muhlenbergii (Meisn.), S. Watson (*P. amphibium*, L.)
var. terrestre (Willd.); Harvey.
persicaria, L. Little Rock, as a weed—Coville.
sagittatum, L.; Lesquereux.
setaceum, Baldwin. Near Argenta. This species does not appear to be clearly different from *P. hydropiperoides*—Coville.
tenue, Michx.; Nuttall, Coville.
virginianum, L.

Rumex, L.
acetosella, L.
crispus, L.; Lesquereux; Walnut Ridge, Blatchley.
hastatulus, Baldw.; Butler.
maritimus, L.; Nuttall, Coville.
verticillatus, L; Nuttall; southern part of State, Harvey.

Brunnichia, Banks.
cirrhosa, Banks.

ARISTOLOCHIACEÆ.

Asarum, L.
canadense, L.

Aristolochia, L.
serpentaria, L; Lesquereux.
tomentosa, Sims.

PIPERACEÆ.

Saururus, L.
cernuus, L.

LAURACEÆ.

Persea, Gærtn.
carolinensis (Michx.), Nees; Harvey.

Sassafras, Nees.
officinale, Nees.
Lindera, Thunb.
benzoin (L.), Meisn.

THYMELEACEÆ,

Dirca, L.
palustris, L.

LORANTHACEÆ.

Phoradendron, Nutt,
flavescens (Pursh), Nutt.

SANTALACEÆ.

Pyrularia, Michx.
pubera, Michx.; Nuttall.
Comandra, Nutt.
umbellata (L.), Nutt.; Nuttall, Harvey.

EUPHORBIACEÆ.

Euphorbia, L.
cordifolia, Ell. Waste grounds near the Union Depot, Little Rock—Coville.
corollata, L.
dentata, Michx.; Nuttall, Harvey.
heterophylla, L. Nuttall, Harvey; Hot Springs, Letterman.
var. graminifolia (Michx.), Engelm.; Nuttall.
hexagona, Nutt.; Nuttall.
hypericifolia, L. It is probable that this is the plant now passing under the name of *E. preslii*, Guss.—Coville.
longicruris, Scheele; Nuttall.
maculata, L.
obtusata, Pursh; Nuttall, Harvey.
petaloidea, Engelm.; Nuttall.
Phyllanthus, L.
carolinensis, Walt.

Jatropha, L.
stimulosa, Michx.; Nuttall, Harvey.
urens, L.
Croton, L.
capitatus, Michx.
glandulosus, L.
linearis, Jacq.; Hempstead county, Harvey.
monanthogynus, Michx.
Crotonopsis, Michx.
linearis, Michx.
Argythamnia, P. Browne.
mercurialina, Muell.
Acalypha, L.
caroliniana, Walt. In a cultivated field in the valley of the White River near Batesville.—Coville.
virginica, L.
var. gracilens (Gray), Muell.
Tragia, Plum.
macrocarpa, Willd.; Harvey; Hot Springs, Letterman.
nepetæfolia, Cav. (*T. urticæfolia*, Michx.)
Stillingia, Gard.
sylvatica, L

URTICACEÆ.

Ulmus, L.
alata, Michx.
americana, L.
crassifolia, Nutt.
fulva, Michx.
Planera, Gmel.
aquatica (Walt.), Gmel.; Harvey, Letterman.
Celtis, L.
mississippiensis, Bosc.
occidentalis, L.
var. pumila (Pursh), Gray; Gray.

Humulus, L.
lupulus, L.
Cannabis, L.
sativa, L.; Lesquereux.
Ioxylon, Raf.
pomiferum, Raf. (*Maclura aurantiaca*, Nutt.)
Morus, L.
rubra, L.
Urtica, L.
chamædryoides, Pursh; Nuttall, Harvey.
gracilis, Ait.; Nuttall.
urens, L.; Nuttall.
Laportea, Gaudich.
canadensis (L.), Gaud.
Bœhmeria, Jacq.
cylindrica (L.), Willd.
Parietaria, L.
pennsylvanica, Muhl.

PLATANACEÆ.

Platanus, L.
occidentalis, L.

JUGLANDACEÆ.

Hicoria, Raf. (*Carya*, Nutt.)
alba (L.), Britt. (*C. tomentosa*, Nutt.)
aquatica (Michx. f.) Britt. (*C. aquatica*, Nutt.)
glabra (Mill.) Britt. (*C. porcina*, Nutt.)
minima (Marsh.), Britt. (*C. amara*, Nutt.)
myristicæformis (Michx. f.) Britt.; Harvey.
ovata (Mill.), Britt. (*C. alba*, Nutt.)
pecan (Marsh.) Britt. (*C. olivæformis*, Nutt.)
sulcata (Willd.), Britt.; Lesquereux, Harvey.
Juglans, L.
cinerea, L.
nigra, L.

MYRICACEÆ.

Myrica, L.

cerifera, L.

CUPULIFERÆ.

Betula, L.

nigra, L.; Coville, Blatchley, Harvey, Simonds, etc. Nuttall reported a birch under the name of *B. populifolia.* It seems quite unlikely that the *B. populifolia* of Aiton occurs in Arkansas; and although *B. nigra* was at that time separated from the above species, I must believe that Nuttall meant *B. nigra*, as now understood, for he does not otherwise mention it—Coville.

Alnus, Gærtn.

serulata, Willd.

Carpinus, L.

caroliniana, Walt. (*C. americana.*)

Ostrya, Scop.

virginiana (Mill.), Willd.

Corylus, L.

americana, Walt.

Quercus, L.

alba, L.

aquatica, Walt.

bicolor, Willd.

coccinea, Wang.

falcata, Michx.

imbricaria, Michx.

lyrata, Walt.

macrocarpa, Michx.

michauxii, Nutt.

muhlenbergii, Engelm.; Harvey, Call.

nigra, L.; Nuttall.

prinus L. Reported by Nuttall and Lesquereux under the name of *O. montana*, Willd—Coville.

rubra, L.

tinctoria, Bartr.

Castanea, Gærtn.

(*vesca*, L., reported by Lesquereux, appears to have been *C. pumila*.)

pumila, Mill.

Fagus, L.

ferruginea, Ait.

SALICACEÆ.

Salix, L.

discolor, Muhl.; Lesquereux.

humilis, Muhl. This is the *S. conifera* of Nuttall's Flora of Arkansas—Coville.

longifolia, Muhl.; Nuttall.

nigra, Marsh.

Populus, L.

heterophylla, L.; Harvey.

monilifera, Ait.

CERATOPHYLLACEÆ.

Ceratophyllum, L.

demersum, L.; Nuttall, Lesquereux.

HYDROCHARIDACEÆ.

Elodea, Michx.

canadensis, Michx. f. (*Anarcharis canadensis*, Planch.); Nuttall, Lesquereux.

Vallisneria, L.

spiralis, L.; Nuttall.

Limnobium, Rich.

spongia, Rich.; Lesquereux.

ORCHIDACEÆ.

Microstylis, Nutt.

unifolia (Michx.), BSP. (*M. ophioglossoides*, Nutt.)

Aplectrum, Nutt.

spicatum (Walt.), BSP. (*A. hiemale*, Nutt.); Nuttall.

Corallorhiza, R. Br.

odontorhiza (Sw.), Nutt.; Butler, Harvey.

Tipularis, Nutt.

unifolia (Muhl.), BSP. (*T. discolor*, Nutt.); Nuttall, Harvey.

Hexalectris, Raf.

aphyllas (Nutt.) Raf.; Nuttall, Harvey, Blatchley.

Spiranthes, Rich.

cernua (L. Rich.—"*S. annua*, Rich." in Lesquereux's list is probably a misprint; Coville).

gracilis, Bigel.; Harvey.

præcox (Walt.), S. Watson. (*S. graminea, var. walteri*, Gray.) Grand Prairie, Harvey.

Calopogon, R. Br.

tuberosus (L.), BSP. (*C. pulchellus*, R. Br.); Nuttall, d'Ailly.

Pogonia, Juss.

trianthophorus (Sw.), BSP. (*P. pendula*, Lindl.)

Orchis, L.

spectabilis, L.; Nuttall.

Habenaria, Willd.

ciliaris (L.), R. Br. Harvey herbarium at Arkansas Industrial University; Hot Springs, Letterman; Independence county, near W. B. Frazer's, Coville; near Malvern, Hot Spring county, also in Saline county, d'Ailly; Bradford, second bottoms, Blatchley.

flava (L.), Gray. (*H. virescens*, Spreng.); Nuttall.

lacera (Michx.), R. Br.; Harvey.

leucophæa (Nutt.), Gray; Nuttall.

nivea, Spreng.; Harvey.

peramœna, Gray. Bradford and Newark, Blatchley.

psycodes (L.), Gray; Nuttall.

tridentata (Willd.), Hook. In a sandy swamp at the south end of Main st., Little Rock, Coville.

Cypripedium, L.

parviflorum, Salisb.; Harvey, Blatchley.

ZINGIBERACEÆ.

Thalia, L.

dealbata, Rosc.; Nuttall.

BROMELIACEÆ.

Tillandsia, L.

usneoides, L.; Nuttall. A specimen in the Harvey herbarium at Fayetteville, is labeled "S. E. Arkansas."

HÆMODORACEÆ.

Aletris, L.

farinosa, L.; Harvey.

IRIDACEÆ.

Belamcanda, Adans.

chinensis (L.), Adans. Wild in the streets of Black Rock., St. Lawrence county, Blatchley.

Iris, L.

fulva, Ker. (*I. cuprea*, Pursh.

verna, L.; d'Ailly.

versicolor, L.; Walnut Ridge; Newark, Blatchley.

Sisyrinchium, L.

angustifolium, Mill. (*S. bermudiana*, Gray.) Blatchley, d'Ailly.

mucronatum, Michx.; Harvey, Simonds.

AMARYLLIDACEÆ.

Hypoxis, L.

erecta, L.

Crinum, L.

americanum, L.; Nuttall.

Hymenocallis, Salisb.

occidentalis, Kunth. From Independence county southward. The western plant (not reported as occurring west of the Mississippi) is said to be "apparently distinct from *H. lácera*, Salisb. (*Pancratium rotatum*, Ker.), of the southern coast."—Watson in Gray's Man., 6th Ed.

Agave, L.

virginica, L.

DIOSCOREACEÆ.

Dioscorea, L.

villosa, L.

LILIACEÆ.

Smilax, L.

bona-nox, L.; Nuttall, Coville; Blatchley and Harvey, as *S. tamnoides*, L.

glauca, Walt.

herbacea, L.

lanceolata, L.

laurifolia, L.; Lesquereux, d'Ailly.

rotundifolia, L.

Polygonatum, Adans.

biflorum (Walt.), Ell.; Nuttall.

commutatum (Schult.), Dietr. (*P. giganteum*, Dietr.)

Unifolium, Adans.

racemosum (L.), Britt. (*Smilacina*, Desf.)

stellatum (L.), Greene (*Smilacina*, Desf.); Nuttall.

Yucca, L.

glauca, Nutt., Fraser's Cat. (*Y. angustifolia*, Pursh);

var. mollis, Engelm. This is probably the plant reported as "*Y. recurvifolia?* by Nuttall—Coville.

Nothoscordum, Kunth.

striatum (Jacq.), Kunth; Nuttall, Lesquereux; d'Ailly, Harvey (as *Allium*.)

Allium, L.

canadense, L.

mutabile, Michx.; Butler, d'Ailly.

(The plant reported by Lesquereux as *Allium stellatum*, Nutt., and that by Nuttall as *A. angulosum, var. leucorhizum*, cannot be located with certainty—Coville.)

Camassia, Lindl.

fraseri, Torr.

var. angusta, Torr., Watson, Proc., Amer. Acad., XIV.

Lilium, L.

philadelphicum, L.

superbum, L. *var. carolinianum* (Michx.), Chapm.; Nuttall.

Erythronium, L.

albidum, Nutt.; Nuttall, Harvey.

americanum, Ker.

Chamælirium, Willd.

luteum (L.), Gray (*C. carolinianum*, Willd.); Letterman in Harvey herbarium; Watson.

Tofieldia, Huds.

glabra, Nutt.; Nuttall, Lesquereux.

Uvularia, L.

grandiflora, Smith; Butler.

Oakesia, S. Wats.

sessilifolia (L.), S. Wats. (*Uvularia*, L.); Nuttall.

Medeola, L.

virginiana, L.; Nuttall.

Trillium, L.

sessile, L.; Nuttall.

var. viridescens (Nutt.) *var. nuttallii*, S. Wats.); Nuttall, Harvey.

unguiculatum, Nutt. (*T. recurvatum*, Beck.)

Melanthium, L.

virginicum, L.

Stenanthium.

angustifolium (Prush), Gray; Nuttall.

Amianthium, Gray.

muscætoxicum (Walt,), Gray; Nuttall, Harvey.

PONTEDERIACEÆ.

Pontederia, L.

cordata, L.

Heteranthera, Ruiz & Pav.

limosa, Vahl.; Nuttall.

graminea (Michx.), Vahl. (*Schollera*, Willd.)

XYRIDACEÆ.

Xyris, L.

caroliniana, Walt.; d'Ailly.

torta, Smith; Harvey.

COMMELINACEÆ,

Commelina, L.

hirtella, Vahl. (*C. erecta*, Gray).

virginica, L.

Tradescantia, L.

rosea, Vent.; Nuttall.

virginica, L.

JUNCACEÆ.

Juncus, L.

acuminatus, Michx.; Nuttall, Harvey.

var. debilis (Gray), Engelm. Near Argenta, Coville.

var. diffusissimus (Buchl.), Engelm.; Harvey.

bufonius, L.; Nuttall.

canadensis, J. Gay; Butler.

effusus, L.

filipendulus, Buchl. (*J. leptocaulis*, Torr. & Gr.); Leavenworth, *fide* Engelmann.

marginatus, Rostk.; Nuttall, Harvey.

nodosus, L. *var. texanus*, Engelm. Sandy flood plain of the Arkansas River, near Little Rock.—Coville.

repens, Michx.; Nuttall, Harvey.

scirpoides, Lam.; Engelmann, Harvey.

var. polycephalus (Ell.), Engelm.; Engelmann.

setaceus, Rostk.

tenuis, Willd.

Luzula, DC.

campestris (L.), DC.

PALMÆ.

Sabal, Adans.

adansonii, Guerns. The most northern station observed is near Pine Bluff, Jefferson county. It is common in the bottoms and wet flood plains in all the counties south of that.

TYPHACEÆ.

Typha, L.

latifolia, L.

Sparganium, L.

androcladum (Engelm.) Morong. In a cypress swamp near Argenta. Determined by Mr. Morong.—Coville.

(*simplex*, Huds.; Lesquereux. The precise place of this plant, under the present arrangement of the genus, cannot be made out without specimens.—Coville.)

ARACEÆ.

Arisæma, Mart.

dracontium (L.), Schott.

triphyllum (L.), Torr.

Peltandra, Raf.

virginica (L.), Raf.; Harvey.

Acorus, L.

calamus, L.

LEMNACEÆ.

Lemna, L.

minor, L.; Nuttall, Lesquereux.

trisulca, L.; Lesquereux.

Spierodela, Schleid.

polyrrhiza (L.), Schleid. (*Lemna*, L.); Nuttall, Coville.

ALISMACEÆ

Alisma, L.

plantago, L. *var. triviale* (Pursh). BSP. (*var. americanum*, Gray.)

Sagittaria, L.

graminea, Michx.; Nuttall, Harvey.

variabilis, Engelm.; Nuttall, Harvey. The varieties are not given—Coville.

Echinodorus, Rich.

radicans (Nutt.), Engelm.; Nuttall, Harvey.

rostratus (Nutt.), Engelm.; Nuttall.

NAIADACEÆ.

Potamogeton, L.

amplifolius, Tuck. Power's Creek, about twelve miles southwest of Batesville, Coville.

gramineus, L.; Nuttall.

hybridus, Michx. Polk bayou, about half a mile from Batesville, Coville.

natans, L.

prælongus, Wulf.; Lesquereux.

zosteræfolius, Schum.; Lesquereux.

CYPERACEÆ.

Cyperus, L.

acuminatus, Torr. & Hook. Southeastern part of the state, Harvey.

aristatus, Rottb. (C. *inflexus*, Muhl.) Southeastern part of the state, Harvey.

baldwinnii, Torr. Reported by Nuttall, under the name of *Mariscus echinatus*, Coville.

cyrtolepsis, Torr. & Hook. Eastern part of the state, Harvey.

diandrus, Torr.; Lesquereux, Harvey.

erythrorhizos, Muhl. Southern part of state, Harvey.

esculentus, L.

filiculmis, Vahl.; Harvey.

flavescens, L.

luzulæ, Rottb. *var. umbellulatus*, Britt. (*C. vegetus*, Pursh); Harvey, Britton.

nuttallii, Eddy.; Nuttall.

ovularis (Vahl.), Torrey.

refractus, Engelm. Independence county, Coville; southeast Arkansas, Harvey.

retrofractus, Gray; Nuttall.

rotundus, L.; Nuttall.

stenolepis, Torr.; d'Ailly.

strigosus, L.; Lesquereux, d'Ailly, Harvey. Nuttall's *C. flavicomus* probably goes here, Coville.

uniflorus, Torr. & Hook. Embankment of the Iron Mountain railway near Argenta, Coville.

virens, Michx.; Harvey.

Kyllinga, Rottb.

pumila, Michx.

Dulichium, Pers.

spathaceum (L.), Pers.; Little Rock, Harvey.

Eleocharis, R. Br.

acicularis, (L.), R. Br.; Nuttall, Lesquereux.

ovata, (Roth.) R. Br. (*E. obtusa*, Schultes); Harvey. A form belonging to this species or its *var. engelmanni* (Steud.) Britt., occurs on the bank of the Arkansas, near Little Rock.—Coville.

palustris (L.), R. Br.; Nuttall, Harvey.

pygmæa, Torr.; Nuttall.

quadrangulata (Michx.), R. Br.; Nuttall, Coville.

tenuis (Willd.), Schult.; Harvey.
tuberculosa (Michx.)., R. Br.; d'Ailly.

Fimbristylis, Vahl.
autumnalis (L.), Roem. & Schult.
capillaris (L.), Gray.
castanea, Vahl.; Harvey.
laxa, Vahl.
vahlii (Lam.), Link. (*F. congesta*, Torr.) On the sandy bars of the Arkansas river near Little Rock, Coville.

Scirpus, L.
atrovirens, Muhl.; Harvey.
carinatus (Hook & Arn.), Gray ; Harvey.
lacustris, L.; Nuttall.
lineatus, Michx.; Harvey.
olneyi; Gray. Salado creek, Independence county, Coville.
pungens, Vahl.; Lesquereux, Harvey.

Eriophorum, L.
cyperinum, L. (*Scirpus eriophorum* Michx.) Southern part of the state, Harvey.

Fuirena, Rottb.
squarrosa, Michx.; Nuttall, Lesquereux.

Hemicarpha, Nees.
micrantha (Vahl.), Britt. (*H. subsquarrosa*, Nees.)

Rynchospora, Vahl.
alba (L.), Vahl.; Nuttall.
axillaris (Lam.), Britt. (*R. cephalantha*, Gray); Harvey.
glomerata (L.), Vahl.; Harvey.
harveyi, Bott.; Harvey.
inexpansa (Michx.), Vahl. Southern part of the state, Harvey.
laxa, Vahl. (*R. longirostris*, Michx., Ell.); Nuttall.
R. macrostachya, Torr. of Arkansas is probably the same.

Cladium, P. Br.
effusum, Torr.; Nuttall.

Scleria, Berg.
reticularis Michx.; Nuttall.
triglomerata, Michx.; Harvey.

Carex, L.
cephalophora, Muhl.; Harvey.
crinita, Lam.; Butler.
echinata, Murr. (*C. stellulata*); Butler. Probably what is called *var. microstachys*. Boeckler, by Bailey.
flava, L.; Nuttall.
folliculata, L.; Nuttall.
grayii, Carey. In moist woods at the south end of Main street, Little Rock.—Coville.
grisea, Wahl.
laxiflora, Lam. (*C. anceps*, Muhl.); Nuttall. Harvey.
var heterosperma (Wahl.), ESP. (*var. intermedia*, Boot.); Harvey.
lurida, Wahl. (*C. lupulina*, Muhl.); Nuttall.
muhlenbergii, Schk.
plantaginea, Lam.; Nuttall.
rosea, Schk.; Nuttall; Harvey herbarium at Fayetteville.
var. retroflexa (Muhl.), Torr. (*C. retroflexa*, Muhl.); Harvey.
shortiana, Dew.; Harvey.
squarrosa, L.; Harvey.
stenolepis, Torr.; Butler, Harvey.
stipata, Muhl.; Butler.
straminea, Schk.; Harvey.
var. alata (Torr.), Bailey (*C. alata*, Torr.); Harvey.
tentaculata, Muhl.; Nuttall, Harvey.
tribuloides, Wahl. (*C. lagopodioides*, Schk.); Harvey.
triceps, Michx.; Harvey.

varia, Muhl. (*C. emmonsii*, Dew.); Harvey.
virescens, Muhl.; Butler.
vulpinoidea, Michx.; Butler, Harvey.

GRAMINEÆ.

Paspalum, L.
ciliatifolium, Muhl.; Harvey.
floridanum, Michx.; Butler, Harvey.
fluitans, Kunth; Harvey.
læve, Michx.
purpurascens, Ell.; Nuttall.
racemulosum, Nutt.; Nuttall.
setaceum, Michx.
stoloniferum, L.; Nuttall.

Anthænantia, Beauv.
villosa (Kunth), Beauv.; Nuttall, as *Panicum ignoratum*.

Panicum, L.
agrostoides, Muhl.; Nuttall, Harvey.
anceps, Michx.
capillare, L.; Nuttall, Harvey.
clandestinum, L.; Lesquereux, Harvey.
colonum, L.; Harvey.
crus-galli, L.; Nuttall, Lesquereux.
debile, Poir. (*P. hians*, Ell.); Nuttall, Lesquereux, Harvey.
depauperatum, Muhl.; Harvey. On the face of the rocky cliff at Mountain Park, near Little Rock, Coville.
dichotomum, L.
filiforme, L.; Nuttall. This is considerably out of range for this species—Coville.
gibbum, Ell.; Nuttall.
latifolium, L.
microcarpon, Muhl.; Nuttall.

nitidum, Lam.; Coville. Dr. Vasey concludes that this form must be separated from *P. dichotomum*. It has undoubtedly been found by others, but referred to the latter species—Coville.

proliferum, Lam. *var. geniculatum* (Ell.), Vasey; Nuttall.

sanguinale, L.

scoparium, Lam.; Coville, Harvey. Nuttall's *P. pauciflorum* probably goes here—Coville.

verrucosum, Muhl.; Nuttall.

virgatum, L.

Oplismenus, Beauv.

setarius, R. & S.; Nuttall.

Setaria, Beauv.

glauca (L.), Beauv.

Cenchrus, L.

tribuloides, L.; Nuttall, d'Ailly.

Spartina, Schreb.

cynosuroides (L.), Willd.; Nuttall, Harvey.

(*polystachya*, Michx., Willd.; Nuttall. The occurrence of this plant in Arkansas is doubtful—Coville.)

Tripsacum, L.

dactyloides, L.

Zizania, L.

aquatica, L.; Nuttall, Lesquereux.

miliacea, Michx.; Nuttall.

Homalocenchrus, Mieg. (*Leersia*, Sw.)

lenticularis (Michx.), Harvey.

oryzoides (L.), Poll.

virginica (Willd.), Britt.

Thurberia, Benth.

arkansana (Nutt.), Benth.; Nuttall.

Erianthus, Michx.

saccharoides Michx. (including *E. contortus.* Ell.); Nuttall.

Rottbœllia, L.

cylindrica (Michx.) Torrey. (*R. campestris*, Nutt.); Butler, Harvey. (Specimen in the National Herbarium).

Andropogon, L.

glomeratus (Walt.), BSP. (*A. macrourus*, Michx.); Nuttall.

provincialis, Lam.; Lesquereux, Harvey.

scoparius, Michx.; Lesquereux, Harvey.

virginicus, L.

Chrysopogon, Trin.

nutans (L.), Benth.; Lesquereux, Harvey.

var. avenaceus (Michx.) (*C. avenaceus*, Michx.), Benth.; Harvey.

Phalaris, L.

intermedia Bosc. Reported also by Nuttall as *P. occidentalis*, Coville.

Alopecurus, L.

geniculatus, L.; Nuttall.

var. aristulatus (Michx.), Munro; Butler, Harvey.

Aristida, L.

dichotoma, L.; Nuttall.

gracilis, Ell.; Lesquereux, Harvey.

oligantha, Michx.; Nuttall, Harvey.

pallens, Nutt.; Nuttall.

purpurascens, Poir.; Harvey.

purpurea, Nutt.; Nuttall.

stricta, Michx.; Nuttall, Lesquereux.

tuberculosa, Nutt.; Lesquereux.

Stipa, L.

avenacea, L.; Nuttall, d'Ailly.

viridula, Trin.? (*S. parviflora*); Nuttall.

Muhlenbergia, Schreb.

capillaris, Kunth; Nuttall.

diffusa, Schreb.; Nuttall, Lesquereux.

mexicana (L.), Trin.; Lesquereux.

var. filiformis, Vasey; Harvey.

sobolifera (Muhl.) Trin.; on the limestone bluff along the White River, five miles above Batesville, Coville; Harvey.

sylvatica (Torr.), Torr. & Gr.

tenuiflora (Willd.), BSP. (*M. willdenovii*, Trin.); Nuttall.

Brachyelytrum, Beauv.

aristosum (Michx.), Beauv. (as *B. aristatum*); Nuttall.

Aporobolus, R. Br.

asper (Michx.), Kunth.

heterolepis, Gray; Harvey.

indicus, R. Br.; Harvey. Streets of Little Rock, Coville. Reported by Nuttall, but outside the present boundaries of Arkansas, Coville.

vaginæflorus (Torr.), Vasey; Lesquereux.

Agrostis, L.

alba, L. *var. vulgaris* (With.), Thurber; Nuttall, Harvey.

perennans (Walt.), Tuck.; Nuttall.

hiemalis (Walt.), BSP. (*A. scabra*, Willd.); Nuttall, Harvey.

Cinna, L.

arundinacea, L.

Deyeuxia, Clar.

canadensis (Michx.), Beauv.; Nuttall; Lesquereux.

Ammophila, Host.

longifolia (Gray), Benth.; Nuttall.

Danthonia, DC.

spicata (L.) Beauv.; Nuttall.

Cynodon, Pers.

dactylon (L.) Pers.

Ctenium, Pauz.
americanum, Spreng.; Nuttall.
Chloris, Sw.
cucullata, Bisch. Vasey in Descriptive Catalogue of the Grasses of the United States.—Coville.
verticillata, Nutt.; Nuttall. Probably outside the present boundaries of the State.—Coville.
Gymnopogon, Beauv.
ambiguus (Michx.), BSP. (*G. racemosus*, Beauv.)
Schedonnardus, Steud.
paniculatus (Nutt.) (*S. texanus*, Steud.); Nuttall, Lesquereux.
Bouteloua, Lag.
curtipendula (Michx.); Gray. (*B. racemosa*, Lag.)
oligostachya, Torr.; Nuttall.
Eleusine, Gærtn.
indica (L.), Gærtn.
Leptochloa, Beauv.
mucronata, Kunth; Nuttall, Harvey.
Triodia, R. Br.
seslerioides (Michx.), Benth.
stricta (Nutt.), Benth.; Nuttall, Harvey.
trinerviglumis (Munro), Benth.; Harvey.
Diplachne, Beauv.
fascicularis (Lam.), Beauv.; Nuttall, Coville.
Triplasis, Beauv.
purpurea (Walt.), Chapm.; Nuttall.
Phragmites, Trin.
vulgaris (Lam.), BSP. (*P. communis*, Trin.); Lesquereux.
Kœleria, Pers.
cristata (L.), Pers.; Nuttall, Harvey.
Eatonia, Raf.
obtusata (Michx.), Gray; Nuttall.
pennsylvanica, (Spreng.); Gray, Nuttall, Harvey.

Eragrostis, Beauv.

capillaris (L), Nees.; Nuttall, d'Ailly.
conferta (Ell.), Trin.; Nuttall.
frankii, Meyer; Harvey.
hypnoides (Lam.), BSP. (*E. reptans*, Nees.)
major, Host.; Butler.
minor, Host.; Nuttall.
interrupta (Nutt.) (*E. oxylepis*, Torr.).
pectinacea (Michx.); Gray, Nuttall.
purshii, Schrad.; Harvey. In the streets of Little Rock—Coville. The plant reported by Nuttall as *E. pilosa* is undoubtedly of this species—Coville.
tenuis (Ell.), Gray; Nuttall, Harvey.

Melica, L.

mutica, Walt.; d'Ailly.
var. diffusa (Pursh), Gray; Harvey.

Diarrhena, Raf.

diandra (Michx.), Hitchc. (*D. americana*, Beauv.); Nuttall, Lesquereux.

Uniola, L.

latafolia, Michx.
laxa (L.), BSP. *U. gracilis*, Michx.)

Distichlis, Raf.

maritima, Raf.; Nuttall.

Poa, L.

annua, L.
nemoralis, L.; Nuttall.
pratensis, L.; Nuttall.
sylvestris, Gr.; Butler, Harvey.

Glyceria, R. Br.

fluitans (L.), R. Br.; Nuttall, Harvey.
nervata (Willd.), Trin.; Nuttall, Harvey.

Festuca, L.

elatior, L.; Nuttall, Lesquereux. The form is undoubtedly of the var. *pratensis*, (L)—Coville.

nutans, Willd.; Butler, Harvey.
octoflora, Walt. (*F. tenella*, Willd.); Nuttall, Harvey.
sciurea, Nutt.; Nuttall. Probably outside the present limits of the state—Coville.

Bromus, L.
ciliatus, L.
purgans, L. (*B. ciliatus*, L. *var. purgans*, L., Gray); Harvey.

Hordeum, L.
jubatum, L.; Harvey.
pusillum, Nutt.; Nuttall, Lesquereux.

Elymus, L.
canadensis, L.; Nuttall.
striatus, Willd.
virginicus, L.

Asprella, Willd. (*Gymnostichum*, Schr.)
hystrix (L.), Willd; Harvey.

Arundinaria, Michx.
macrosperma, Michx.; Nuttall, Lesquereux.
var. suffruticosa, Munro; Nuttall.

CONIFERÆ.

Pinus, L.
echinata, Mill. (*P. mitis*, Michx.)
inops, Ait.; Nuttall.
rigida, Mill.; Nuttall. Harvey is of the opinion that neither *P. inops* nor *P. rigida* is found within the state—Coville.
tæda, L.

Taxodium, L.
distichum, Rich.

Juniperus, L.
virginiana, L.

SELAGINELLACEÆ.

Selaginella Beauv.
apus (L.) Spring.; Lesquereux, Coville.
rupestris (L.) Spring.; Lesquereux.

RHIZOCARPEÆ.

Marsilia, L.

uncinata, A. Br. Underwood, in Our Native Ferns and their Allies, p. 115—Coville.

(The autonomy of the plant reported by Lesquereux, under the name of *M. mucronata*, Willd., as found by Nuttall, is uncertain—Coville.)

Pilularia,

americana, A. Br. Underwood, l. c., p. 116—Coville.

Azolla, Lam.

caroliniana, Willd.

OPHIOGLOSSACEÆ.

Ophioglossum, L.

vulgatum, L.; Nuttall, Harvey.

Botrychium, Sw.

ternatum (Thunb.), Sw.; Nuttall, Harvey.

var. obliquum (Muhl.), Milde; Nuttall, Harvey.

virginianum (L.), Sw.

FILICES.

Polypodium, L.

incanum, Sw.

vulgare, L.

Notholæna, R. Br.

dealbata, Kunze; Harvey.

Adiantum, L.

capillus-veneris, L.; Lesquereux, Harvey.

pedatum, L.

Pteris, L.

aquilina, L.

var. candata (L.), Hook.; Coville, Harvey.

Cheilanthes, Sw.

alabamensis, Kunze.

eatoni, Baker. In clefts in the rocks at Mountain Park, Big Rock, near Little Rock—Coville.

lanuginosa, Nutt.; Butler, Harvey.

tomentosa, Link.; Lesquereux, Harvey.
vestita (Spreng.), Sw.

Pellæa, Link.
atropurpurea (L.), Link.

Woodwardia, Smith.
areolata (L.), Moore (*W. angustifolia*, Smith); Harvey.
virginica (L.), Smith; Nuttall, Harvey.

Asplenium, L.
angustifolium, Michx.; Nuttall, Harvey.
bradleyi, D. C. Eat.; Harvey, Coville.
filix-fœmina (L.), Bernh.
parvulum, Mart. and Gal.; Harvey, Call.
pinnatifidum (Muhl.), Nutt.; Lesquereux, Harvey.
platyneuron (L.) Oakes, (*A. ebeneum*, Ait.)
ruta-muraria, L.; Nuttall; Lesquereux.
trichomanes, L.

Camptosorus, Link.
rhizophyllus (L.), Link.

Phegopteris, Fee.
hexagonoptera (L.), Fee.

Aspidium, Sw.
acrostichoides (Mich.), Sw.
cristatum (L.), Sw.
marginale (L.), Sw.
noveboracense (L.), Sw.; Harvey.
spinulosum, Sw.; Lesquereux.
thelypteris (L.), Sw.; Lesquereux, Harvey.

Cystopteris, Bernh.
bulbifera (L.), Bernh.; Harvey.
fragilis (L.), Bernh.

Onoclea, L.
sensibilis, L.

Woodsia, R. Br.
obtusa (Spreng.), Torr.

Osmunda, L.

cinnamomea, L.

regalis, L.

EQUISETACEÆ.

Equisetum, L.

hyemale, L.

RICCIACEÆ.

Riccia, Mich.

fluitans, L. *var. sullivantii*, Aust. In a swamp near Argenta. Another variety was found on the flood plain of the Arkansas near the Iron Mountain Railway bridge at Little Rock—Coville.

tenuis, Aust. In a swamp near Argenta—Coville.

(Some other puzzling forms of Riccias were found, which, as they were incomplete, could not be determined—Coville).

MARCHANTIACEÆ.

Asterella.

hemispherica, Beauv. In the Hot Springs—Lesquereux.

Dumortiera, Nees.

hirsuta, Nees. By a spring in the water-shed of Salado creek, Independence county—Coville.

Conocephalus.

cocicus, Dumort. Independence county—Coville.

ANTHOCEROTACEÆ.

Anthoceros, Mich.

lævis, L. In a swamp near Argenta; also by a chalybeate spring in section 15, township 12 N., 7 W.—Coville.

JUNGERMANNIACEÆ.

Aneura, Dum.

palmata, Nees. In a swamp near Argenta—Coville.

Frullania, Raddi.

squarrosa, Nees. On the bark of a specimen of *Quercus nigra* on the hills west of Little Rock—Coville.

virginica, Gottsche. Frequent on the bark of trees near Little Rock—Coville.

kunzei, Lehm. On a quartz boulder in the pine barrens west of Little Rock—Coville.

Phragmicoma.

clypeata, Sulliv. On the bark of a tree in a swamp near Argenta—Coville.

NOTES ON THE BOTANY OF ARKANSAS.

By F. V. Coville.

My field work on the Botany of Arkansas began on the 5th of July and ended August 17, 1887. Of this time two and a half weeks were spent at Little Rock, the remainder in Independence and Stone counties.

From the botanical notes taken, the following report has been prepared. It must be borne in mind that many of the notes, particularly those on the distribution of species, which are of great value only when a large number have been collected, are necessarily omitted.

The reason that so comparatively little is known of the botany of this State is, to a great extent, due to the scarcity here of amateur botanists. The study of botany "for the fun of it" presents in every country so much that is both useful and pleasant, and in Arkansas, in addition, so much that is unknown, that the writer most heartily commends to the people of the State a careful study of their own wild plants.

The amateur will ordinarily begin his work by preserving a pressed specimen of each kind of plant that he meets with; and finding, if he can, its scientific name and common name. As a preface to this a short study of some work on structural botany is necessary. Gray's Lessons in Botany (1), in which directions for preserving plants are also given, answers the purpose admirably. For determining the names, the best book is Chapman's Flora of the Southern States (2.) Dried speci-

(1). Lessons in Botany, by Asa Gray (Revised, 1887). Ivison, Blakeman, Taylor & Co., New York.

(2). Flora of the Southern United States. By A. W. Chapman (Second edition). Ivison, Blakeman, Taylor & Co., New York.

mens of plants that the student is unable to determine should be sent to some competent botanist for identification.

The botanical characteristics of the region.—That part of the State in which our observations were made may be divided, for botanical purposes, into bottoms and uplands. The cultivated parts of the bottoms are largely devoted to the raising of corn and cotton. The wild parts are forests, or swamps, or flood plains.

In prairie regions the woods are confined to narrow strips along the margins of the streams; but in some districts, as near Olyphant, on the St. Louis, Iron Mountain and Southern Railway, the whole bottom is covered with a magnificent growth of timber. The most abundant trees of these forests are the sycamore, cottonwood, white oak, post oak, elm, hackberry, honey locust and sweet gum.

In the narrow strips above mentioned, the vegetation has a somewhat different character, forming dark matted copses. The trees are smaller and contain a different group of species. The box elder (*Negundo aceroides*), redbud, winter grape (*Vitis riparia*), two other grapes (*V. indivisa* and *bipinnata*), and the two canes (*Arundinaria macrosperma*, Mx., and *A. tecta*) are abundant in these places.

The swamps present a peculiar and fascinating appearance. Their most prominent feature is the magnificent bald cypresses (*Taxodium distichum.*) These trees grow in three feet or less of water, their enlarged conical bases partly submerged, and their "knees" projecting from the surrounding water like the stumps of young trees. On the surface of the water is often a bright, green scum composed of duckweeds (*Lemna* and *Spirodela*) and *Azolla*. In the center of the swamp the water is deeper, from six to eight feet, devoid of trees, filled with white water-lilies (*Nymphæa tuberosa* of Paine) and surrounded by a fringe of bur-reeds (*Sparganium* and *Rocladum* of Engelmann.) A few cranes give the spot a lazy animation, the whole being dark, gloomy and tropical.

On the Arkansas the immediate flood plains or bars are sandy or muddy, according to the swiftness of the current in high water; are too moist for cultivation, devoid of trees, and have a scanty herbaceous vegetation. These flood plains appear to be the first resting places of many of the introduced weeds.

The uplands are hills a few hundred feet in height, separated by deep valleys. Most of the rivulets that come down the hillsides are dry in summer, so that nowhere were seen those moss-covered, verdant, wet ravines so frequently met with in mountainous districts.

When the hills are rocky they are practically covered by one immense forest, the land having been cleared only in patches here and there. The soil of the hills is often of sandstone origin and varies in its vegetation according to its depth. On the summits of some of the hills, where the soil is thin and the sandstone crops out or lies near the surface, the timber is light, the commonest and most characteristic tree being the black jack (*Quercus nigra*).

For the most part, however, the upland sandstone soil is deeper and bears a heavy growth of valuable timber. The short-leaved pine, post oak, white oak and hickory are the most valuable trees. At the present time much of this timber is wasted by girdling the trees, and after a few years burning the dead trunks, for the sake of clearing the land for agricultural purposes. "Deadenings," as they are called, of twenty acres or more, with corn planted among the standing trunks, are a common sight.

Besides the sandstone soil of the uplands, there is in many localities a limestone soil. The vegetation of these districts is markedly different from that of similarly situated sandstone soils. These differences are given below. Such land, when cleared, is well adapted for growing wheat.

It must be kept in mind that these observations on the kinds of soil met with apply merely to the region passed

through. For example, while the bottom lands are here largely under cultivation, in other parts of the state large areas of such exceedingly fertile soil lie uncleared. The predominance of sandy soil in the uplands, and the presence on the tops of the hills of black jack timber is merely local.

The effect of soil on the distribution of plants.—A portion of the writer's work in Independence county was to trace the parting between a stratum of sandstone and an underlying stratum of limestone. From the first it was noticed that the vegetation borne on the two soils formed from these rocks varied in general aspect, but when it came to stating the precise items of difference some difficulty was experienced, for lists of the plants seen on each of the soils were nearly identical. After a short time, however, the difference began to be perceptible. It lies in the preponderance of certain species, a very few possibly being limited to one of the soils. The difference is most strikingly seen upon hillsides, the bases of which are of limestone, the summits of sandstone. On the former soil the most abundant trees are the redbud (*Cercis canadensis*), the chestnut oak (*Quercus prinoides*), the black walnut and the shell-bark hickory (*Carya alba*). Rarely was any one of the first three of these found in the sandy soil above. The last mentioned is abundant in both situations. The sugar maple (*Acer saccharinum*) was sometimes found on the limestone, but never on the sandstone. The same is true of a skullcap (*Scuttellaria versicolor*) and the harebell (*Campanula americana*). The other trees, which constitute the great majority of species, are scattered about equally over both soils. The height of the limestone above the bottoms of the valleys varies from two to three hundred feet down to nothing, while the change in vegetation is abrupt and coincides invariably with the change in soil, so that the climatic differences between the top and bottom of the hills are not the cause of a difference in vegetation. The depth of soil, too, appears to be about the same in both cases.

It appears certain, then, that the moulding influence, in this case at least, lies in the character of the soil. That action of the soil, however, which produces the above stated effects, may be either mechanical or chemical. It is to be noted, too, that the plants mentioned above as abundant on the limestone occur also abundantly in alluvial soil, and it is probably true that each one of these species has been found in other localities on both sandstone and limestone.

It appears, then, that under the same climatic conditions, the kind of soil materially effects the distribution of plants; certain species, while not absolutely requiring a particular soil, at least prefer it, and upon it stand a much better chance of survival.*

ECONOMIC NOTES.

Grazing plants.—Among the plants of economic value, *Lespedeza striata*, "Japanese clover," is worthy of especial notice. It is evidently a *Lespedeza*, though it does not agree with any of our described species.

According to the reports current among farmers, the plant was first seen in abundance from five to ten years ago. Whether then introduced or indigenous, they did not know. A gentleman informs me that the plant is also found abundantly in

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*To Professor Coville's results we have to add the observations made by Dr. J Francis Williams in studying the geology of Magnet Cove in Hot Spring county. Dr. Williams' work has been upon the geology of the eruptive rocks, and he finds it a rule with scarcely an exception that the pine does not grow upon soils derived from eruptive rocks, though it is very abundant in the adjacent areas of sedimentary rocks. See An. Rep. Geol. Survey of Ark., for 1890, Vol. II.

Such cases have fallen under my own observation in several places in the State, but I have usually found that the effect of soil upon tree growths manifests itself in the number of individuals present, rather than in the simple presence or absence of species. In Vol. II, pp. 56-57, of the Reports for 1888, Professor Hill has referred to the preference of the pine of southwest Arkansas for the Tertiary and Post-tertiary soils. The predominance of pine in the case he refers to is very marked, though pine is not confined to those geologic formations. It is simply a difference in quantity, but one which amounts to as sharp a division line as that between such colors as black and gray.—J. C. BRANNER.

Mississippi, where it has been known for many years. It is called quite generally throughout Arkansas and in Mississippi also, "Japanese clover." The characteristics of the plant that render it particularly valuable are, first, that it will grow in soil of extreme sterility; second, that it is an excellent grazing plant.

In the pine barrens south of Little Rock and on the dry summits of hills, it grows to a height of three or four inches, somewhat scantily to be sure, but nevertheless in sufficient amount for pasturage. In moister, deeper and less exposed soil, it grows to the height of a foot, and affords the best grazing. Cattle are very fond of it. The plant will undoubtedly become still more abundant.*

Bermuda grass (*Cynodon dactylon*) is a small, creeping plant resembling the common crab-grass both in habit and in its flower clusters, but it is smaller. In the country traversed, it appears only as a weed, and not in great abundance. It is spreading rapidly, and is considered, on the whole, the most valuable grazing plant of the South. A figure is given in the bulletin mentioned above, p. 25. This plant together with the crab-grass (*Panicum sanguinale*) should be encouraged in all places where pasturage is needed.

Weeds.—The weeds observed in Arkansas are very different from those of the eastern States, the latter being largely made up of plants introduced from Europe, while the weeds of Arkansas are mostly natives of the United States. Some of the most energetic of the trans-Atlantic species have, however, reached Arkansas. Conspicuous among these is the crab-grass (*Panicum sanguinale*), which is a most persistent pest in cultivated grounds. This is considered by the farming people

*It should be stated here that the sketch of this plant as given above, except the name, was written before seeing Dr. Vasey's account of it in Bulletin No. 3, of the Botanical Division of the Department of Agriculture, on the Grasses of the South. It is there stated to have been introduced from China about forty years ago, and to have become very valuable as a grazing plant throughout the Gulf States. An excellent figure is given in the above mentioned bulletin, p. 47.

the worst weed that they have to contend with. It spreads rapidly by the seed, so that it can scarcely be eradicated, but it must be kept down by constant plowing and hoeing. In its proper place, however, as a forage plant it is valuable, and is to some extent cut for hay.

Another very troublesome weed, a native of our own country, is the Spanish needles (*Bidens bipinnata*), which vies in persistence with the crab-grass.

The purslane (*Portulaca oleracea*), or "pusley," as it is more commonly pronounced, holds its place here as elsewhere.

In cornfields, two species of morning glory (one of them *Ipomœa nil*) and another plant called blue-vine (*Cocculus carolinus*) does considerable damage. All three are twiners, and choke and bend the cornstalks; frequently so overrunning a field as to seriously impede the progress of a person walking through it.

Three species of Cassia (*C. marilandica*, *C. obtusifolia*, and *C. occidentalis*) grow abundantly in the waste places about villages, being particularly abundant at Batesville and at Grand Glaise.

Yellow dog-fennel (*Helenium tenuifolium*) and white dog-fennel (*Maruta cotula*) are abundant, their usual habitat being along highways and on village commons, where they hold undisputed ground, for they are disliked by cattle. The yellow dog-fennel seems to confine itself to, or perhaps only yet to have become established in the lowlands.

In the streets of Little Rock the common weeds are *Chenopodium ambrosioides*, *Amarantus spinosus*, and *Solanum carolinianum*. *Solanum rostratum*, introduced from farther west, is beginning to appear along the railways, and promises to be a handsome weed, if nothing more.

A plant that has been long cultivated in the farming districts as an out-door ornament will add one more weed to the flora of Arkansas. This is *Pardanthus chinensis*, popularly known as "flag." It has escaped from cultivation in many

places in Independence county, and flourishes in fence corners, along roadsides, and even in thickets and woods. The seeds are not well adapted for wide and rapid dissemination; and the plant spreads mostly down hill, the seeds being carried along by the water in ditches and gullies. It takes up the ground pretty thoroughly as far as it goes, growing in large patches; but it is not difficult to keep in check, as one or a few plowings are sufficient to kill it.

Plants worthy of cultivation.—The beauty of many of the wild flowers of Arkansas is particularly striking to one unaccustomed to that flora. Those who make a business of the cultivation of flowers would do well to turn their eyes toward this state for the selection of worthy additions to their list.

Argemone mexicana, the prickly poppy, although an introduced plant, may be included among the others. This plant resembles a common poppy, but the leaves are prickly. The flower is three to four inches in diameter, and of a pure white color in all the specimens seen. It would undoubtedly grow well in dry soil.

Pancratium rotatum is a remarkably handsome plant, about two feet high, with amaryllis-like leaves, and a tall scape bearing a cluster of a few large, white flowers, each with a central crown bearing along its margin the yellow anthers.

Agave virginica, the false aloe, is a plant related to the one just mentioned. At the ground there is a tuft of thick, stiff, dagger-like spiny leaves, from the center of which arises a slender naked stalk about five feet high, bearing along its upper part the peculiar, small, yellowish, fragrant flowers.

Monarda punctata, called in the botanies "horse mint," is a plant two or three feet high, bearing numerous spreading, aromatic leaves, topped with a close, large head of open-jawed flowers, rose-purple and yellow, spotted with brown. It is a common wayside plant, abundant near Little Rock.

Passiflora incarnata, which is here called "apricot," is a straggling, careless vine with triple-lobed leaves and flowers of

the peculiar passion-flower form, two inches in diameter and mottled with two shades of pale purple.

An Aster, *A patens; Bignonia capreolata*, the cross-vine; *Campanula americana*, the harebell; *Nymphæa tuberosa* and *odorata*, the white water lilies; *Nelumbium lutum*, the yellow lotus; *Polymnia canadensis* and *Uvedalia;* all of the *Pycnanthemums*, and the little moss-like *Selaginella apus*, certainly deserve cultivation.

Among trees, *Rhus glabra* and *copallina*, the sweet gum (*Liguidambar*), and the bald cypress (*Taxodium distichum*) would be in many respects ornamental.

Miscellaneous notes.—The fruit of the black sumac (*Rhus copallina*), and the white sumac (*Rhus glabra*) produces on its surface a slippery whitish transparent coating, which is composed largely of malic acid. The writer was accustomed when thirsty, after walking for several hours in the hot sun, to take these little seed-like fruits in his mouth and suck off the acid coating. The effect is like that of any acid drink, under similar circumstances, cooling and invigorating. The acid is easily dissolved in warm water, and with the addition of sugar would be a healthful and pleasant drink. The inner part of the fruit is not poisonous, and the whole of it is sometimes eaten.

A plant, of which only a mutilated specimen was seen, but which is probably *Nicandra physaloides*, is an excellent fly poison. The method of using it is to pound up the stems and leaves, so that the juice may be readily expelled, and then to put the whole mass into a pan partly filled with buttermilk. The flies are attracted by the buttermilk, and killed by the juice of the plant. The name given to this flower is "twelve o'clock," from the fact that the corolla opens, for a little time only, about mid-day. A similar use is made of the seeds of the coffee bean (*Gymnocladus canadensis*), they being pounded up and applied in the same way. Chair bottoms, and excellent ones too, are made of the inner bark of the basswood (*Tilia americana* and its variety), this tree being the stock source of

the material used in some localities for that purpose. The bark is divided into thin strips about three-fourths of an inch wide, and these are woven across the chair after the manner of basket work.

There is another subject in economic botany that deserves to be looked into more thoroughly than the writer was able to do in the brief time at his disposal; that is, the utilization of natural fruits, and the cultivation of those already known. The fruit of the wild plum (*Prunus americana*), several of the red haws (*Cratægus*), the muscadine (*Vitis vulpina*), the persimmon (*Diospyros virginiana*), and the black haw (*Viburnum prunifolium*) are, to say the least palatable; and some of these and many other trees would undoubtedly make excellent stocks for the grafting of the best varieties of fruit now cultivated.

The natural adaptation of the upland soil to the cultivation of fruit is undoubtedly great, as may be inferred from the original vegetation, and as demonstrated by the success of the little that is already cultivated. Unfortunately there seems to be an apathy among the farmers to the innovation of growing fruit for a distant market, and usually, too, those who have attempted it have not been careful to procure the varieties best adapted for such purposes. But for those who will go at the matter energetically and carefully, there is an excellent opening.

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